WATER QUALITY MONITORING PROTOCOLS - REPORT NO. 8

PROTOCOLS FOR CLASSIFYING, MONITORING, AND EVALUATING STREAM/RIPARIAN VEGETATION ON IDAHO RANGELAND STREAMS

Idaho Department of Health and Welfare

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INTRODUCTION

This document defines appropriate parameters and outlines specific monitoring protocols and procedures for evaluating streamside vegetation and streambank stability for Idaho's small (usually less than 30 feet wide) rangeland streams. It also provides protocols for monitoring stream canopy cover, streambank stability, solar input, and establishing permanent photo points associated with livestock grazing and other activities that affect streamside (riparian) vegetation and beneficial uses of water. These protocols are directed at three of the important pollutant sources affecting the biological integrity of streams and lakes that may result from livestock grazing: streambank erosion, water temperature, and vegetation.

Livestock grazing is an important economic use of Idaho range and pasture lands. Recent emphasis on water quality and riparian area values (e.g., flood plain functions, livestock forage, wildlife and fish habitat, and water storage) requires improved management of livestock on these areas. Monitoring the impacts of livestock grazing provides for refining management and protection of those values.

Riparian vegetation is critical for protecting streambanks. Riparian vegetation in good condition prevents streambank erosion, traps sediment, reduces solar radiation into streams, and maintains productivity along streams (Chaney et al 1990). Instant rehabilitation of unhealthy streambanks is an unrealistic expectation, but streamside vegetation usually responds more quickly to changes in management than other habitat components, such as streambank morphology, water temperature, biological indicators, and chemical constituents.

Scope of Application

There are two distinct types of riparian vegetation along Idaho streams: riparian systems dominated by forest overstory and rangeland systems dominated by shrub/herbaceous vegetation. Forest canopy dominated streams in Idaho most frequently occur in mountain settings and usually have gradients of more than one and one-half percent. Rangeland grass/shrub dominated streams occur in intermontane valleys, mountain meadows, and plains. They generally occur on gradients of less than two percent.

Forested Mountain Streams

Forested mountain streams are not the focus of this document. Water Quality Monitoring Protocols Report numbers 1, 2, 3, and 4 (IDHW 1990b, 1991b, 1991c, and 1991d), address sediment impacts to salmonid incubation, intercobble space, and pool/substrate stability. In addition, Hankin and Reeves (1988) developed an excellent basin-wide method for inventorying and monitoring habitat structure and diversity and fish abundance.

Rangeland and Pasture Land Streams

Rangeland streams are generally located in meadows and valleys at lower elevations in Idaho. Stream gradients are predominantly less than two percent. Grasses and grass-like plants, shrubs, and woodland (e.g., cottonwood) overstory dominate the natural riparian vegetation.

Riparian vegetation is a critical part of healthy aquatic ecosystems (Platts 1991). Removing or modifying riparian vegetation, along with mechanical bank damage, reduces stability of stream channels, resulting in negative impacts to fish productivity (Platts and Nelson 1989b). Reducing bank cover such as overhanging vegetation, deep strong vegetation roots, and undercut bank reduces fish production, particularly in salmonids (Wesche 1980; Binns 1979; Sullivan et al. 1987). Erosion resulting from streambank destabilization usually increases substrate embeddedness (Shepard 1989; Nelson et al. 1990; Hawkins et al. 1983). Increased substrate embeddedness limits food production and reduces refuge areas for young trout (Rinne 1990). Procedures for evaluating substrate embeddedness and undercut banks are in the Water Quality Protocols Reports Numbers 2 and 4 (IDHW 1991d).

Vegetation canopy over small streams intercepts solar radiation, reduces its intensity during the summer, decreases water temperatures, and protects salmonid species (Platts 1991). It also reduces the amount of heat radiated away from the stream in the winter, reducing the formation of anchor ice (ice that forms on the bottom of the stream), which may damage the habitat when it moves during high flows (Platts 1991).

These protocols are designed for smaller rangeland streams, usually less than 30 feet average width. Care must be taken when using them on large streams.

STRATIFICATION, RECONNAISSANCE, AND CLASSIFICATION OF RANGELAND RIVERINE RIPARIAN AREAS

Protecting or enhancing beneficial uses of water is the main goal of the Nonpoint Source Pollution Management Program (IDHW 1989). Livestock grazing, along with other agricultural activities, has been identified as a major contributor to stream pollution. Improper livestock use, such as season long grazing, can cause sedimentation from accelerated streambank erosion, increased water temperatures due to vegetation removal, and reduction of fish habitat resulting from the physical breakdown of streambanks.

This protocol also describes the three levels of data required for implementing the Idaho Antidegradation Policy (IDHW 1991a): basic, reconnaissance, and intensive.

The *basic level* is a compilation of existing information and stratification of the stream and its associated riparian area. The *reconnaissance level* is a reconnaissance field level inventory used to refine the basic data and gather additional data needed to classify a stream and its riparian area. It is also used to choose the location of *intensive level* monitoring sites.

Intensive monitoring provides site-specific data for evaluating the effectiveness of best management practices (BMP), trend of habitat factors, and status of beneficial uses.

All streams are not equal. Streams vary in size, velocity, geomorphology, erosion/deposition, vegetation, and other factors according to position in the landscape. A monitoring strategy requires stratifying or dividing the stream into sub-areas based on natural features, land use, and sampling requirements. An intensive monitoring site is select within a sub-area that represents and reflects conditions and changes along a segment of a stream.

The sampling strategy described here is *stratified-systematic* as defined by Gilbert (1987). Using this strategy, the stream is divided into non-overlapping strata. Each strata is systematically sampled to allow characterization of each strata. Statistical studies show this method is preferred over other sampling strategies for estimating means, totals, and patterns (Gilbert 1987). Because individual strata or sub-areas are usually too large, a monitoring site is selected to represent the whole stream segment. This, however, does not allow for uniform coverage of the population and may result in observer bias.

To minimize observer bias, factors such as geology, landform, soils, stream gradient, stream order, stream flow, land use, land ownership, and elevation are used to define the location of monitoring sites. Sites are also chosen for intensive monitoring for comparison (such as reference or control sites) that may be used to establish objectives and evaluate results of management.

Basic Level

The basic level is a compilation of existing information and stratification of the stream. It is usually done in the office from maps, aerial photos, existing data, and information from other agencies (e.g., Idaho Department of Fish and Game, U.S. Geological Survey, Idaho Division of Environmental Quality, universities, Soil Conservation Service). This information provides the basis for the initial delineation of streams into sub-areas having similar characteristics, allowing streams and riparian areas to be classified. Factors to be considered:

1. **Stream gradient** is determined from topographic maps by plotting elevations in relation to distance and expressed as a percentage. Breaks along the stream are usually made at all distinct changes in gradient. Minimum gradient breaks are: less than 2 percent, 2 to 3.9 percent, and 4 percent or more. Appendix B contains critical gradient breaks for stream typing.

2. **Stream order** changes usually provide breaks along a stream. They usually represent a change in the hydrologic characteristics of the stream.

3. **Sinuosity** is the ratio of the length of the stream divided by the length of the valley bottom. It is usually obtained by carefully measuring the length of the stream and the valley bottom on topographic maps. Sinuosity breaks are < 1.2, 1.2 to 1.4, and > 1.4.

4. **Soil family** and **geology** are usually closely related and may be used to further subdivide streams. Soil surveys and/or geologic maps provide this information.

5. **Valley bottom** types are defined from topographic maps and described in Appendix B are logical braking points along a stream. (See Appendix B)

6. **Other features**, such as vegetation, land use, land ownership, diversions, culverts, instream structures, as well as other observable features may be used to define sub-areas. Compile information on topographic maps and the forms shown in Appendix A.

7. **Information sources** should be listed on the form shown in Appendix A.

Reconnaissance Level and Classification

The reconnaissance level is a field inventory of existing conditions. It provides information needed to refine sub-area breaks, classify stream segments, locate intensive monitoring sites, and provide information to determine the present condition of the stream and riparian area. Other factors affecting water quality are also recorded.

It is critical that an interdisciplinary team (usually includes an plant specialist, fishery biologist, hydrologist, soil scientist, and other specialists as appropriate) conduct the reconnaissance level inventory since no one individual is expert in evaluating all components of the reconnaissance inventory and the classification.

Classification is the interpretation of data collected and consisting of the dominant soil family, stream type (Rosgen), and the existing dominant riparian community. Classification systems used by the U.S. Forest Service, Bureau of Land Management, and Soil Conservation Service are acceptable.

1. Review in detail the information obtained from the Basic Level for each sub-area. Provide each team member a map containing the sub-area boundaries, important features, and other information (soil survey data, water quality data, vegetation information, stream features, diversions) that will assist with the reconnaissance level inventory. Team members should have adequate copies of maps and aerial photos.

2. Determine the intensity of data collection for the stream habitat (see below) appropriate to the

resource values, public interest, and anticipated intensive monitoring sites.

Single Ocular Estimate: A single estimate is recorded for each element on the Stream Habitat data sheet for each sub-area. This is done by the appropriate team members walking the entire stream, keeping mental or written notes, and making average estimate for each element the end of the sub-area. (USDA 1992)

Make notes of problems and issues of concern (i.e. severe streambank erosion, tributaries, irrigation return flows, good habitat conditions). Note the location on a map.

This is the lowest level and least cost alternative for data collection and has the lowest replicability between observers. It also does not provide adequate information to understand the spatial variability of the various habitat attributes within the sub-area. It provides information on conditions of one sub-area compared to other sub-areas. (USDA 1992)

Representative Segment Estimate: The team walks the entire length of the sub-area and selects a segment that best represents the sub-area. Select a starting point at random and estimate stream attributes for five contiguous habitat units or one meander cycle (a meander cycle is usually 5 to 7 times the bankfull width), whichever is greater. Data for each habitat unit is entered on to the Stream Habitat Data Sheet. The intensive monitoring site may also be used to describe the riparian vegetation, soil family, and stream channel type. Note the location of the intensive monitoring site on the map. (USDA 1992)

Note on the Field Data Sheets any problems and issues of concern (i.e., severe streambank erosion, tributaries, irrigation return flows, good habitat conditions). Note the location on a map.

This method provides limited information concerning the spacial variability of the various habitat attributes. It is assumed that the intensive monitoring site provides a good representation of the sub-area.

Multiple Sample Estimate: Five noncontiguous stream segments are sampled within a sub-area. Fewer stream segments may be used for short (less than 3,000 feet) sub-areas. The starting point for each sample segment is predetermined on a map or aerial photo prior to walking the length of the sub-area. Each sampled segment will be at least one meander cycle long or five contiguous habitat units. Habitat attributes are recorded for each habitat unit within the segment. (USDA 1992)

Note on the Field Data Sheets any problems and issues of concern (i.e., severe streambank erosion, tributaries, irrigation return flows, good habitat conditions). Note the location on a map.

3. Walk the entire length of each sub-area, each team member providing the information for which they are responsible. If a sub-area needs to be divided as a result of information obtained on the ground, each team member must be given the information and a new sub-area designated. A Riparian Classification and Stream Habitat Data Sheet will be completed for each sub-area.

4. Identify and record dominant riparian community types. Determine the appropriate riparian community using an accepted classification system (see Appendix B).

5. Use accepted soil survey procedures to determine dominant soil families along the stream. Order 2 soil surveys usually provide sufficient detail for classification.

6. Record required information on both the Riparian Classification and Stream Habitat Field Data Sheet. Record the sub-area classification: sub-area number, dominant soil family, stream type, and dominant vegetation community.

7. Photograph stream channel, green line vegetation, channel alterations, erosion problems, or other factors contributing to the condition of the stream. Care must be taken to note the photograph location, direction, date, and other important information. It may be useful to plot the location on the map.

8. Evaluate all of the information collected for the stream, and determine the factors limiting water quality (pollution), the sources of the pollution (streambanks, irrigation return flows, roads, mining), and the apparent cause of the pollution (livestock grazing, irrigation, road maintenance, road construction, urban runoff).

MONITORING PROTOCOLS FOR VEGETATION AND STREAMBANKS

Parameters in this protocol include riparian vegetation, light input, streambank stability, and permanent photo points. Appendix C has field data sheets for recording information. This section describes the measurement technique. Data analysis and evaluation are in Stream/Riparian Evaluation.

Each of the following parameters are functional determinants of the beneficial use support and water quality in small Idaho rangeland streams. Each relates to livestock grazing impacts and is considered a sensitive management indicator.

Locating Intensive Monitoring Sites

Determine the desired level of monitoring necessary to evaluate BMP implementation, BMP effectiveness, beneficial use status, and trend monitoring for the stream. The level of monitoring should reflect resource values, beneficial use status, public health, or other factors affecting water quality.

Implementation monitoring is critical for evaluating activity impacts on water quality. It answers the question: Are the BMPs being implemented as they were planned? Implementation monitoring consists of use supervision, contract administration, and vegetation utilization. Implementation monitoring will be conducted on each management unit (i.e., allotment, ranch unit, pasture, field).

BMP effectiveness monitoring is the most frequently applied monitoring along a stream area. It is located within each important management unit and may range in complexity from a single permanent photo point to monitoring several parameters (i.e., green line vegetation, streambank stability, canopy cover, embeddedness, substrate, water temperature, nutrient loading).

Beneficial use status monitoring is usually installed at key points along the stream to provide sufficient information to evaluate the status of the beneficial uses on the stream. Parameters at these may include fish, macroinvertebrates, water chemistry, temperature, dissolved oxygen, cobble embeddedness, and/or other critical factors.

The sampling scheme described below may be used for selecting and laying out an intensive monitoring sites:

1. Select the sub-area to be monitored. Consider the pollutants impacting the stream, BMP to be implemented, potential reaction to management, major pollution sources, stream hydrologic functions, and resource values.

2. Walk the selected entire length of the sub-area, recording the location and length of all slow water (pools and glides) and fast water (riffles and runs). (See Appendix B.) Record only pools whose width equals or exceeds about half the average stream bankfull width.

3. Determine average density of fast water and slow water habitat types by adding the total length of each habitat, and dividing each by the total stream reach length. If, for example, 200 feet of slow water are measured in a total stream distance of 1000 feet, the density equals 200/1000, or 0.2 per foot.

4. Select an intensive monitoring site that has a similar slow water and fast water density as the overall sub-area sample. The monitoring site reach length should either be equal to or greater than 20 times the bankfull width of the stream or 360 feet, whichever is greater. Thus, a stream 25 feet wide would have a reach of at least 25 X 20, or 500 feet. If the bankfull width is 15 feet, 15 X 20 is 300 feet, 360 feet will be used.

5. Place a witness marker (e.g., a steel post, marked fence post, or permanently marked tree) at the downstream starting point on the intensive monitoring site and at a point ten feet upstream from the intensive monitoring site marker. Then place a cross-channel transect marker stake for the study site on either side of the stream and above the high water level.

6. Place 22 *transect stakes* (two for each cross-channel transect) on each side of the stream equidistant from the marker to the upper end of the intensive monitoring site. The 11 pairs of stakes should be above the high water (bankfull) level of the stream and oriented so the line connecting them is roughly perpendicular to the stream thalweg at the high water level. If an intensive monitoring site equals 1,000 feet, for example, the 11 cross-channel transects would be at 100 foot intervals along the channel thalweg. Put a witness marker, similar to the site marker, ten feet upstream from the eleventh cross-channel transect marker and on the right side to help relocate the monitoring site should the downstream marker be removed or destroyed.

7. Mark each cross-channel transect stake with fluorescent paint, bright colored caps, and/or flagging to simplify relocation. It is also helpful to identify each transect by attaching a numbered metal tag to each cross-channel transect marker on the right side of the stream.

   Record all numbered transects for future reference. If stakes are lost after initial installation, relocate and replace them by using the previously established (and recorded) spacing. Thus, it is important to record the location of the intensive monitoring site marker, transect locations, and spacing in the field notes. Record the information on the Permanent Monitoring Site Location Data form, shown in Appendix C. Provide a location map with enough information so the intensive monitoring site may be relocated. Prepare a detailed map of the cross-channel transect location (Figure 1). Secondary transect markers are suggested on streams that are very unstable. Document any changes.

After establishing and describing the intensive monitoring site, sample collecting baseline and trend data over time. According to Coffey et al (1991), baseline monitoring before implementation of nonpoint source controls is usually required to show causality. They suggest at least two years of pre-implementation monitoring to calibrate the site to the reference condition. Less time may be needed with parameters that integrate temporal variability, such as physical habitat, macroinvertebrates, and fish.

Parameters strongly tied to stream flow, such as chemical constituents, require at least two years of baseline monitoring because of large temporal variability. With these parameters, it is hard to detect a statistically significant treatment effect without sufficient baseline data.

Coffey et al (1991) state that monitoring comparable reference sites is the most effective design for sensing treatment effects. However, comparison with the resource value ratings based on the desired future condition may also be used. The strategy for cause-and-effect assessment using reference sites and/or resource value ratings is discussed in Section III - Evaluation. Monitoring conducted at both the treatment and reference sites separates the impacts of treatment from natural effects.

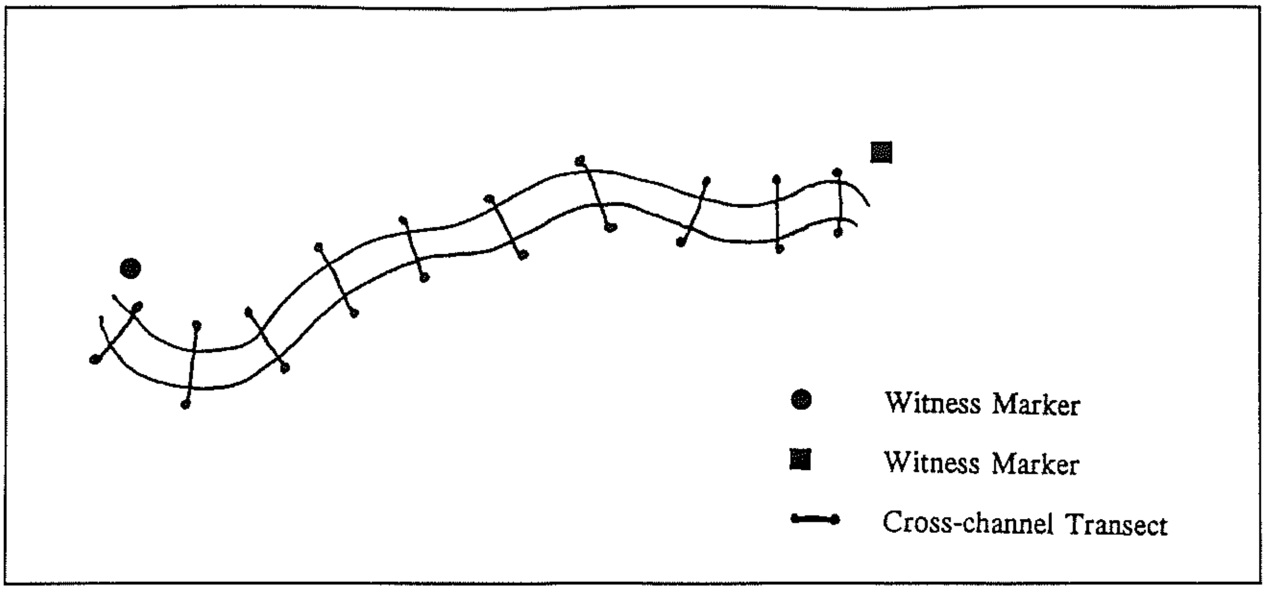

Figure 1. Detailed intensive monitoring site and cross-channel transect map.

Select a reference area by finding the nearest stream/riparian reach that matches the classification from step 1 at the treatment site. Follow the "Locating Intensive Monitoring Sites" procedures (described above) to locate the intensive monitoring site within the reference site or comparison area. The reference site does *not* have to be in natural, undeveloped condition but in a *desired* condition. Such sites often receive grazing--but at intensities or with grazing systems that protect or enhance stream/riparian conditions. Reference areas on the same stream, upstream of pollutant activities are preferred. However, if the stream lacks the desired conditions, the use of nearby like classified streams is acceptable.

In the absence of reference areas, desired future conditions should be established for the appropriate parameters for the intensive monitoring site. Exclosures that eliminate livestock grazing from a small segment of the stream provide a good comparison between the implemented BMPs and no-livestock grazing. They are also valuable for evaluating and refining site-specific objectives or the future desired condition, potential changes that should be expected, and the rate of change expected from BMP implementation. An interdisciplinary team is normally required to establish reasonable parameters. The team will use all available information, exclosures, literature, and experience to establish the future desired condition.

Riparian Vegetation

Green Line

The *green line* (USDA 1992) is the first continuous cover of perennial vegetation above the stable low water level on or on top of the streambank (Figures 2 and 3). Anchored logs, large boulders that will not move during intense floods, and bedrock are recorded in place of a riparian community. The green line may be at water's edge or away from the stream above a gravel bar, vertical bank, or other feature (see Figure 4). The hydric plants forming the green line are normally the most effective control of nonpoint source pollution (e.g., sediment, thermal, and nutrients). Non-hydric (upland) species may exist on the green line but these are usually less effective. The width of the communities along the green line vary from less than one foot to several hundred feet and may cover the entire floodplain.

Measuring vegetation conditions on this green line, where the forces of stream erosion play their most dominant role, usually provides the earliest indication of change of riparian conditions after application of or changes to BMPs. Water is usually not the factor limiting vegetation productivity along the green line of a stream. Regardless of outside forces such as livestock grazing, nature continually tries to grow green, water-loving plants along the green line.

Use the Field Data Sheet-Green Line in Appendix B to record the data. The following steps describe the green line vegetation monitoring procedure:

1. Begin on either side of the stream at the first cross-channel marker stake and proceed along the green line. Using a measuring tape, measuring rod, measuring wheel, or other method, find the lineal length of each community type along the green line in the intensive monitoring site.

2. Measure and record lengths for each community type, log, boulder, or bedrock. (See Figures 2, 3, and 4.) Record each change in community type of one foot or more along the green line for each transect on the intensive monitoring site.

3. Cross the stream and repeat the procedure along the opposite bank.

4. Compute the total number of feet and composition of each community type along the green line by adding the total feet of each community type and dividing by total number of feet measured. Include both sides of the channel.

5. Record the composition of the dominant community types as a percent of the total composition along the green line as shown in Table 3 (page 23).

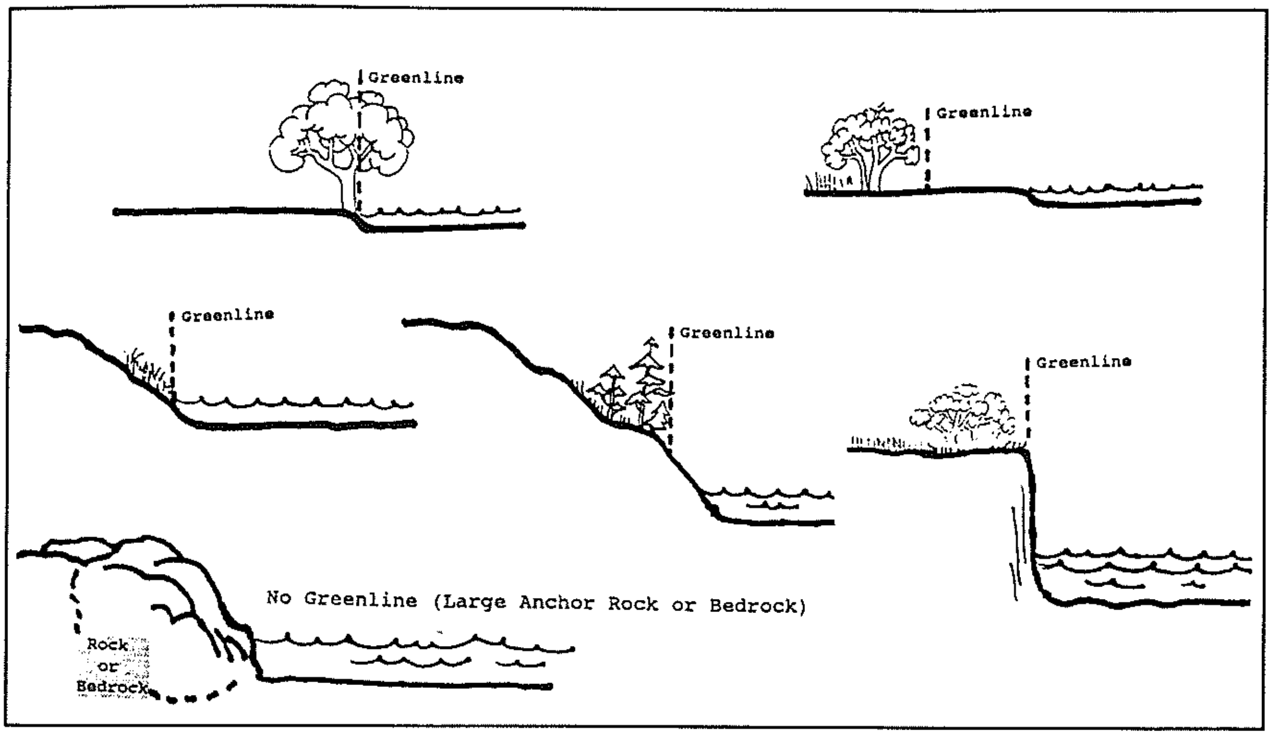

Figure 2. Green line vegetation's proximity to the water's edge.

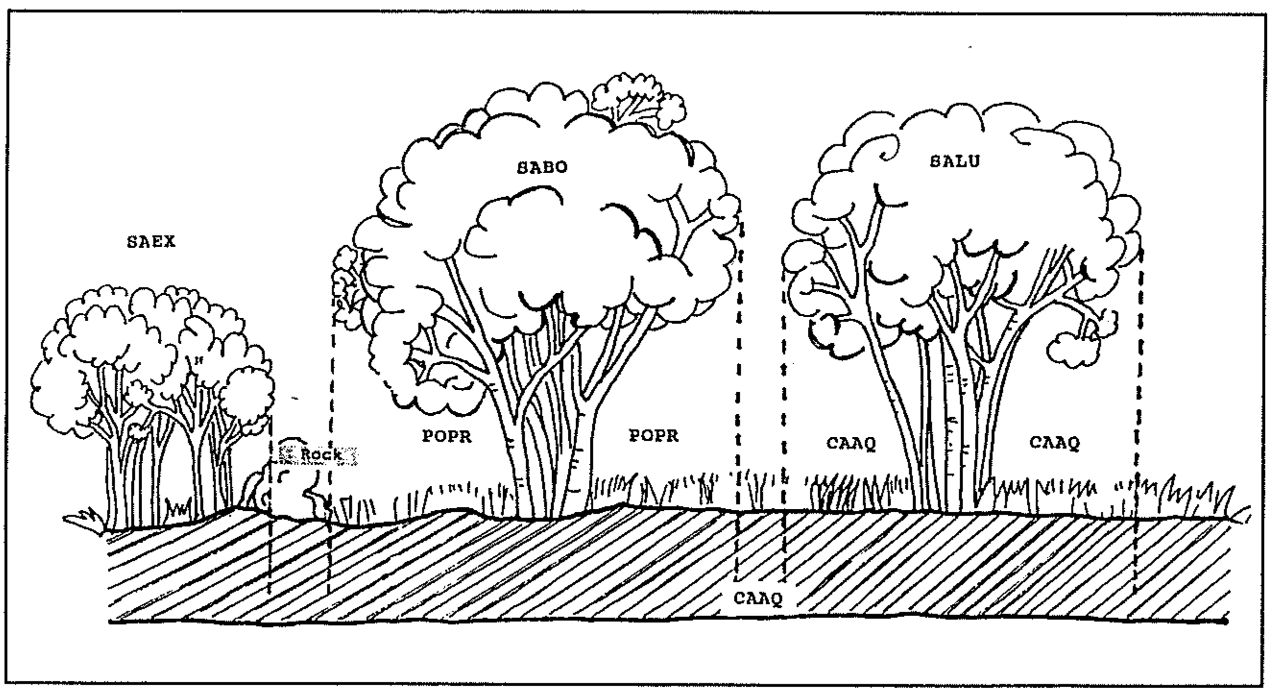

Figure 3. Canopy cover describes the riparian communities on the green line.

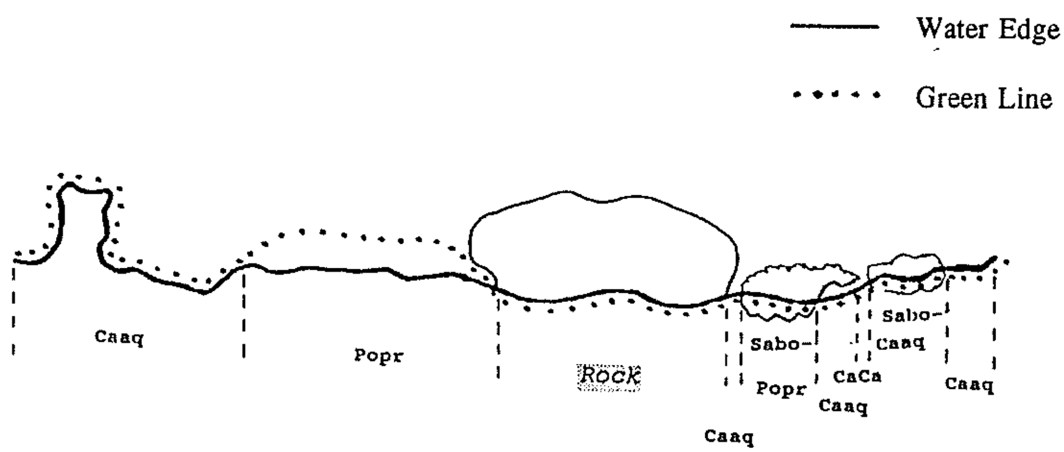

Figure 4. Describing and measuring green line vegetation.

Woody Species Age Class

The woody species age class composition is a good indicator of the vegetative trend on the green line (USDA 1992). Young age class woody plants grazed by livestock or wildlife reduces the amount of healthy woody species on a site (USDA 1987 and Kovalchik 1992). A high proportion of sprouts, young, and mature shrubs indicates an upward trend shrub-dominated riparian zone (Kovalchik 1992). Low proportions of these plants indicates static or downward trends. The woody regeneration survey applies to stream/riparian areas where shrubs such as willow are potentially significant in the green line vegetation composition.

Woody species age class along the streambanks is measured using a six foot belt transect within the intensive monitoring site. The same measurements can be made within the like-classed reference reach. The degree of similarity defines woody regeneration status as described in Section III.

1. Begin on either side of the stream at cross-channel transect marker number 1. (See Green Line Vegetation above.) Proceed down the green line holding the center of a six foot rod directly over the waterside edge of the green line. (See Figure 5.)

2. Assess the age class, and tally all woody plants by species rooted beneath the length of the rod (three feet on either side of rod center) for all twenty linear transects (both sides of the stream) as follows:

Number of Stems	Age Class
Number of stems = 1	: sprout
Number of stems = 2 to 10	: young
Number of stems > 10, > 1/2 alive	: mature
Number of stems > 10, < 1/2 alive	: decadent
Number of stems = 0 stems alive	: dead

NOTE: Do not use with single stem species such as *Salix exigua* and cottonwood species. Rather, count the total number of live vigorous sprouts as young.

3. Add and record the total number of each species of shrub in each age class encountered along the green line. Record the composition of each age class as a percentage of the total number of shrubs measured in the reach. (See Table 4, page 24.)

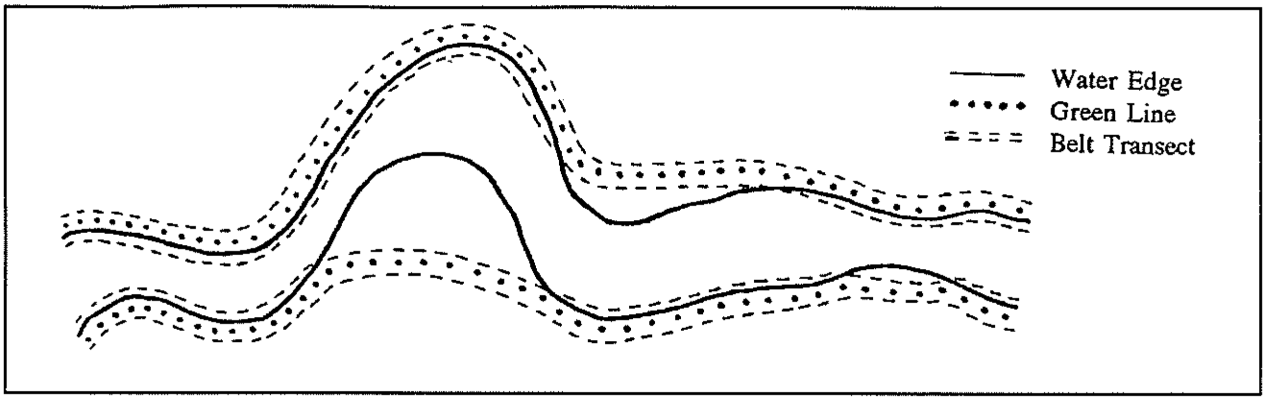

Figure 5. Woody species age class transect.

NOTE: The green line may move as vegetation establishes on barren areas. An example of this is cottonwoods establishing on a point bar. The point bar continues to build, and coyote willow (*Salix exigua*) and other riparian vegetation establishes on the point bar between the stream and the cottonwoods. Measuring the green line does not recognize the cottonwoods. Because this protocol focuses on water quality, the green line vegetation should be assessed. If cottonwood is an important management consideration for the riparian area, establish other procedures for monitoring cottonwoods based on the management objectives.

Vegetation Utilization

Vegetation utilization is a tool to help private landowners, technical experts, and land management agencies meet short- and long-term riparian vegetation and water quality objectives (USDI 1989b). It provides performance standards by which vegetation may be measured to see if livestock grazing BMPs are being implemented in a manner that "demonstrates a *reasonable and knowledgeable* (emphasis added) effort to minimize resulting adverse water quality impacts" (IDHW 1991e). Traditionally, utilization is portrayed as a percent of forage (i.e., vegetation used by livestock or wildlife) removed. The major problem with this method is the difficulty of evaluating or visualizing something already removed (Vallentine 1990), particularly on riparian areas and flood plains associated with surface water. Regrowth may mask the amount of vegetation actually removed.

Herbaceous and woody plant species are important in protecting water quality and fish habitat. Each plant group has unique characteristics and provides important habitat components. Herbaceous species are critical to streambank stability, stable undercut banks, sediment filtering, and limited shading of the stream. Woody species provide all of these things plus a high degree of shading. In addition, animals use the plant groups differently.

Vegetation utilization is used to evaluate whether sufficient vegetative matter remains to protect streambanks, the appropriateness of the intensive monitoring site or key area, distribution of use by large herbivores, competition between livestock and wildlife, and relationship of utilization to vegetation responses (Vallentine 1990). Utilization is a critical link between annual vegetation production and use and the response of vegetation to management. It is also a short term (annually or more frequent) tool to help managers, private and public, adjust livestock and wildlife use to meet water quality standards, maintain or restore healthy riparian communities, and maintain and restore fish habitat.

Herbage Stubble Height. Basing proper use (the amount of vegetation that may be removed and still maintain or enhance the desired vegetation) on plant residue or stubble height rather than on utilization (the amount of plant material removed) may be preferable because the amount of herbaceous plant residue left has the greatest impact on plant health and soil and watershed protection (Vallentine 1990). Measuring the stubble height of herbaceous vegetation at the end of the grazing and growing season is an easy, rapid method of determining if sufficient herbaceous biomass remains to sustain desirable riparian plant communities, maintain plant vigor, provide for a functioning flood plain, and protect the streambank. Clary and Webster (1989) suggest that going into winter, a herbage stubble height of four to six inches is enough vegetative biomass on the green line and floodplain to protect streambanks and flood plain functions. Bryant (personal communications 1991) indicates that a minimum three inches of stubble height on the flood plain is needed to maintain plant vigor and allow for proper flood plain functioning. Some situations (e.g., critical fisheries habitat, poor riparian conditions, or highly erodible soils) may require at least six inches of stubble height.

The following procedure determines average stubble height:

1. Start at cross-channel transect number one and record a minimum of 50 samples on each side of the stream. To determine sampling intervals, divide the length of the transect by the number of samples desired. Determine the sampling points by stretching a tape between transects along the green line or pacing the intervals on the green line.

2. Measure the average stubble height of perennial herbaceous vegetation (forbs, grasses, and grass-likes) on at least 100 sampling points (50 on each side for the stream) for each intensive monitoring site. Do not include woody species.

3. With a yard stick or ruler, measure the height of the perennial herbaceous vegetation nearest the point on the tape or at the tip of the toe for a pace transect. If there is no perennial herbaceous vegetation at the toe or transect point, select the closest perennial herbaceous plant within a 180° arc in front of the observer and one half the distance to the next sampling point. Write "no vegetation" if it does not exist. Record all readings by species and height.

4. Add the stubble heights and number of sampling points with vegetation by species. Find the average stubble height by species and the overall average stubble height for the intensive

monitoring site. (See Table 5, page 24.)

5. Use the same procedure on any area where an average stubble height is needed, particularly on active flood plains. The starting point, distance between readings, and the number of points may be varied to meet particular needs, such as changes in riparian communities, different seasons of use, and different stocking rates. Document the procedure used.

Woody Species Utilization (Twig Count). Maintaining healthy woody riparian communities is critical for protecting water quality, fish habitat, floodplain function, and streambank stability (Culpin 1986). Over-utilization of woody species by large herbivores reduces plant vigor, decreases plant reproduction, and eventually eliminates desired woody plants. Measuring utilization at least annually provides a short-term method for determining if the management of grazing animals meets performance standards designed to maintain and improve woody riparian species and also meets water quality standards (Vallentine 1990).

Myers (1989) indicates that woody species have a critical role in riparian site stability and productivity. Cattle use of deciduous woody species increases significantly in late August and usually remains high through the fall (Myers 1989). Site-specific monitoring of woody species is essential in adjusting stocking rates and seasons of use, since a few days' use can make a significant difference in the amount of utilization (Myers 1989).

Evaluations performed during the grazing season determine when livestock should be moved from the riparian zone. Evaluation done at the end of the grazing season establishes adherence to the grazing area's standard.

A twig count estimates how much woody species growth grazing animals (wildlife or domestic livestock) have removed. It is a rapid process of estimating woody species use (Idaho Department of Fish and Game et al n.d.). It may also be used to calibrate ocular estimates. (See Tables 2, page 23 and 6, page 25.)

Use the following procedures to conduct twig counts:

1. Choose the shrub nearest each marked plot (usually 10 on each side of the stream). Randomly select and determine utilization for at least 20 twigs (current year's growth) available for grazing (less than five feet in height), five from each side of the plant, as browsed or unbrowsed. If the shrub plant does not have 20 twigs, count the total number of twigs on the plant. Repeat the process until all of the plots are complete. Each woody species should be tallied separately. For shrubs that grow as individual twigs (e.g. *Salix exigua)*, count the twigs in a one meter square up to 20 twigs.

2. Total the number of twigs browsed for each woody species and divide by the total number of twigs counted for each species. Multiply by 100 to find the percentage of twigs browsed (Table 6).

   NOTE: Use caution when evaluating shrub utilization as wildlife and livestock may graze each terminal bud, thus indicating 100 percent use. Other methods such as measuring twig lengths, caged plants, or twig diameter may be used.

Ocular Estimate. Another procedure of estimating utilization expresses the results with subjective descriptions (Valentine 1990). This procedure is rapid but subject to the evaluator's bias, experience, and training.

1. Estimate utilization (by category on a 6' X 6' plot directly in front of the observer) along the green line or floodplain at regular intervals for at least 100 points (50 on each side of the stream). Intervals may be paced, measured along a line transect, or done by other suitable methods. Record information on the Field Data Sheet, Utilization - Ocular Estimate (Appendix C) using the following descriptions (Platts 1990 and Valentine 1990):

Rating	Description
Slight (0 to 20%)	Little, if any, use of primary forage species by grazing animals is evident. All of the vegetation biomass is usually undisturbed.
Light (21 to 40%)	Light grazing use evident on primary forage species. Most of the site's potential biomass is intact. No evidence of use on secondary forage species.
Moderate (41 to 60%)	Most primary forage plants have been grazed to some degree along the green line, with little or no use on the less palatable species. Average stubble height is at least 4 inches or half of the plant's full height potential.
Heavy (61 to 80%)	All palatable, primary forage species have been grazed. Most of the less palatable plants have been grazed. Vegetation stubble height is usually over 2 inches.
Severe (81 to 100%)	All accessible vegetation has been used. Stubble height is less than 2 inches. Only root crowns and the root mass remain. Shrub species have been highlined or severely hedged.

Calculations to determine the average utilization are shown on Table 7 (page 25), Stream/Riparian Evaluation.

Streambank Stability

Streambank stability is estimated using a simplified modification of Platts et al (1983). The modification allows for measuring bank stability objectively. This rapid measure requires no specialized equipment.

The streambank is that part of the channel between the water line at stable low flow and bankfull water line, excluding gravel (sand) bars. The streambank is that part of the channel which would be most susceptible to erosion during high water (bankfull) events if vegetation were removed; therefore, it represents the steeper-sloped sides of the stream channel. Bank cover is generally viewed at the vegetative green line, located below the bankfull level but above any natural undercutting bank scour. The banks on both sides of the stream along the entire the intensive monitoring site are measured and delineated into four stability classes with a measuring tape, rod, or wheel. Record data on the Field Data Sheet-Streambank Condition/Overhanging Vegetation. (See Appendix C.)

Covered and Stable (Non-erosional). OVER 50 percent of the streambank surfaces are covered by vegetation in vigorous condition, or the banks are OVER 50 percent covered by materials (large cobble, boulders, or anchored rock) that prevent bank erosion. Streambanks are stable; that is, they DO NOT SHOW indications of alteration such as breakdown, erosion, tension cracking, shearing, or slumping.

Covered and Unstable (Vulnerable). OVER 50 percent of the streambank surfaces are covered by vegetation in vigorous condition, or the banks are OVER 50 percent covered by materials that prevent bank erosion. Streambanks are unstable; that is, they DO SHOW indications of alteration such as breakdown, erosion, tension cracking, shearing, or slumping. Banks showing present erosion must be vertical or near-vertical in form.

Uncovered and Stable (Vulnerable). LESS THAN 50 percent of the streambank surfaces are covered by vegetation in vigorous condition, or the banks are LESS THAN 50 percent covered by materials that do not allow bank erosion. Streambanks are stable; that is, they DO NOT SHOW indications of alteration such as breakdown, erosion, tension cracking, shearing, or slumping. Such banks are bare, but they are not slumping or at a vertical or near-vertical bank angle.

Uncovered and Unstable (Erosional). LESS THAN 50 percent of the streambank surfaces are covered by vegetation in vigorous condition, or the banks are LESS THAN 50 percent covered by materials that do not allow bank erosion. Streambanks are unstable; that is, they DO SHOW indications of alteration such as breakdown, erosion, tension cracking, shearing, or slumping.

Woody Vegetation Stream Cover

Water temperature is highly variable over time because it is strongly related to climate and flow. Habitat impairments affecting temperature are those which alter thermal inputs to the stream (e.g., shade and water surface area exposed). As a surrogate measure of maximum temperature, stream canopy and water width are measured to evaluate solar radiation inputs to the stream. Platts and Nelson (1989) have documented several approaches to measuring stream canopy: canopy density, light intensity, unobstructed sun arc, and average potential daily thermal input. The methods for each is documented in Platts et al (1987). This reference also documents a technique for predicting maximum water temperature from thermal inputs. In Idaho rangeland streams, canopy density, overstory vegetation, and thermal input have the greatest correlation to trout biomass (Platts and Nelson 1989).

Three methods of measuring stream shading are discussed: canopy density, overhanging vegetation, and thermal input.

Canopy Density. Canopy density is the amount of vegetation covering a stream. It is measured with a modified Model C concave spherical densiometer. The following modification to the densiometer improves the measurement of the canopy closure (Platts et al 1987). Place a narrow strip of tape at a right angle forming a "V," providing 17 line intersect recording points as shown in Figure 6. This method is fast and relatively accurate. It should not be used on wide streams where the vegetation canopy does not have the potential to significantly cover the stream.

At each sampling point, hold the densiometer away from the body with the bottom of the V pointing toward the observer. Keep the densiometer level by using the bubble level and by keeping the observer's head reflection almost touching the top grid line (Figure 6). Count and record the number of recording points (line intercept points) surrounding or touching vegetation. (See appendix B.) The number of sampling points on each transect is determined by the stream order. Record the data on the Field Data Sheet-Canopy Density/Thermal Input (Appendix C).

For stream orders 1 through 4, make four readings on each cross-channel transects, 1 through 10. Take one reading facing each bank, over the stream, 12 inches from the water edge, and 12 inches above the water surface. Take readings upstream and downstream and at the center of the stream.

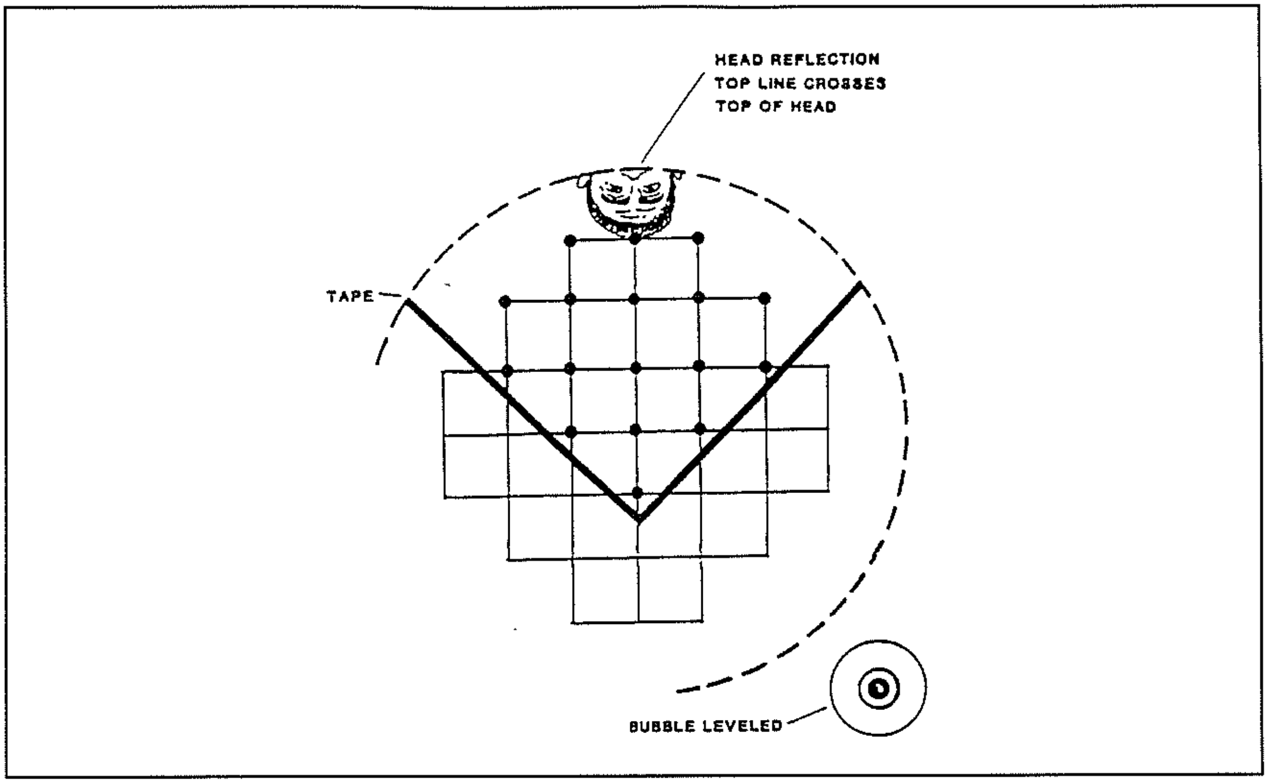

Figure 6. The concave spherical densiometer, Model C with placement of head reflection, bubble level, tape, and 17 points of observation (Platts, et al 1987).

Multiply the total recording points by 1.5 to find the percent canopy density or canopy cover. Average all of the transect densities for the monitoring site.

For stream orders 5 through 7, use the same procedures except take eight readings at each cross-channel transect. Take one reading at each bank and upstream and downstream readings at 1/4, 1/2, and 3/4 distances across the streams. Multiply the total recording points for all eight readings by 0.75. Then deduct one percent if the score is between 30 and 66. Deduct two percent for scores over 66. Make no deductions for scores below 30.

Overhanging Vegetation. The COWFISH technique is a surrogate measure of overstory vegetation (Lloyd 1986). Overhanging vegetation is live vegetation that extends over the water at least 12 inches and within 12 inches of the water's surface. Measure the length of streambank (both sides of the stream) having overhanging vegetation along the monitoring site. Overhanging vegetation may be grass, grass-like, forbs, shrubs, or trees. Record data on the Field Data Sheet-Streambank/Channel Data (Appendix C). Find the percent of the total length (both banks) having overhanging vegetation by dividing the length of bank having overhanging vegetation (total of both banks in the transect) by the total length of both banks. This method is particularly effective on large streams as it is a linear measurement of vegetation over the water providing habitat and direct shading. Computations are shown in Table 10 (page 26).

Thermal Input. This is estimated using a Solar Pathfinder™ following techniques documented by Platts et al (1987). This instrument is a transparent dome mounted on a tripod that reflects an image of the shading objects surrounding the observer. (See figure 7.)

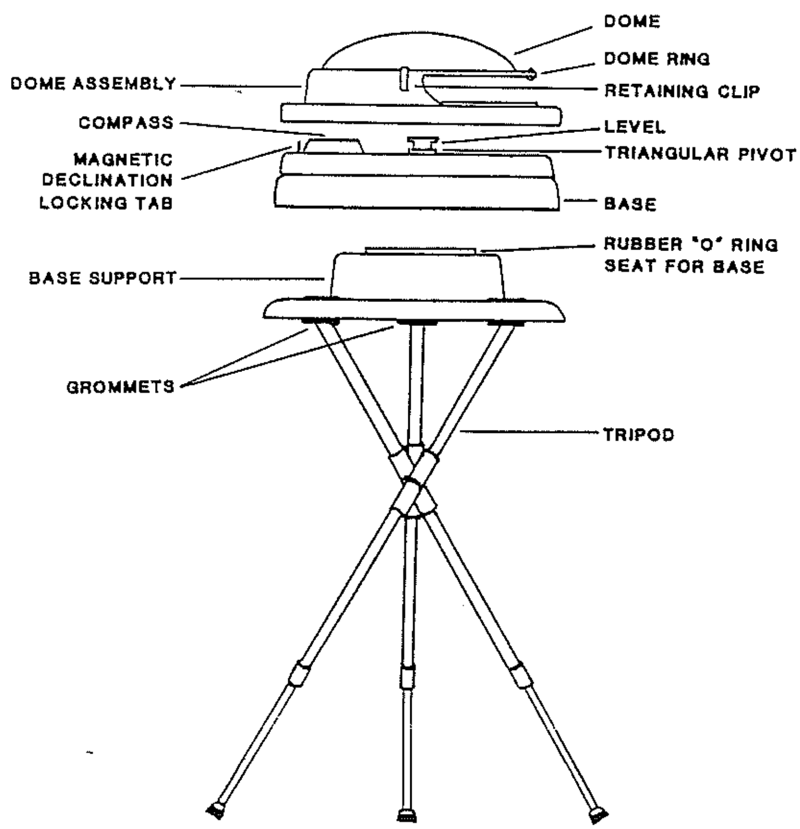

Figure 7. A schematic drawing of the Solar Pathfinder™ with parts (Platts, et al 1987).

The measurement is a quick and accurate estimate of the solar energy entering the stream at any given date. Diagrams estimate the sun path and average energy values for specific locations and times of year. Thus, solar input as influenced by riparian vegetation and other shading objects can be estimated fairly accurately at any time of day or season of the year. Consequently, streambank vegetation can be effectively linked to water temperature. Report the results as a percentage of the potential solar radiation striking a given area of water surface. Take measurements at each cross-channel transect in the monitoring site. Though more time consuming, this is the most accurate method of measuring solar input.

Place the Solar Pathfinder™ in the center of the stream within 6 inches of the water's surface and oriented true south. The instrument has provisions for setting the declination. View the image of surrounding obstacles by looking down into the dome from 12 to 18 inches above the dome. Map the outline of the shading obstacles with a white pencil on the diagram chart (Figure 8). Obtain diagram charts for the proper latitude from the manufacturer.

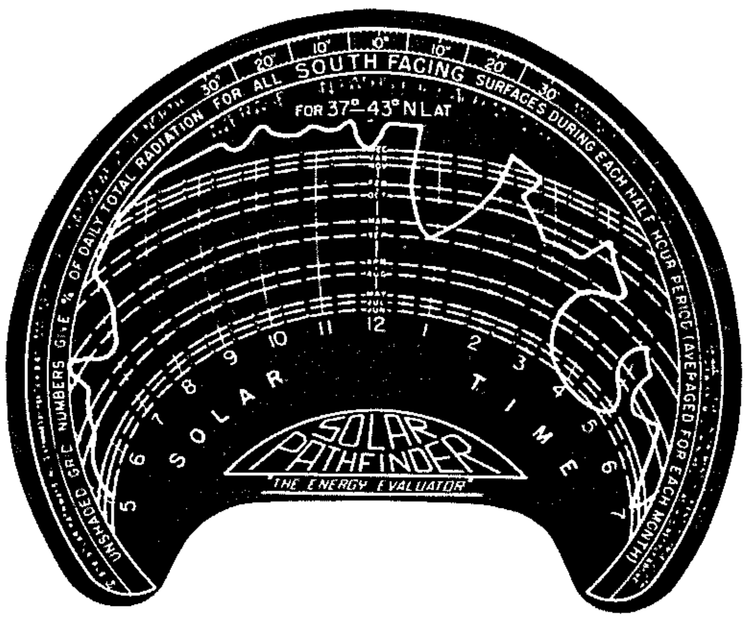

Figure 8. An example of the border between the sky, vegetation, and topography as related to monthly sun-path arc (Platts, et al 1987).

NOTE: Be careful to shade the sun's reflection from the dome as it may be harmful to the eyes.

Total the unshaded numbers by month and record them on the Field Data Sheet-Canopy Density/ Thermal Input (Appendix C). Determine the average for each month and for the critical period, usually June through September. Computations shown are in Table 11 (page 27).

Permanent Photo Points

Photographs provide an excellent visual representation of conditions at a given point in time. Although it is subjective, photography is a relatively easy, inexpensive, and effective method of showing relative change and conditions over time.

Photography is generally used in two ways. First, it visually documents changes in condition over time (trend) for intensive monitoring sites. Second, the information may validate that changes in areas other than the intensively monitored sites are reacting to management like the intensive monitoring sites. Kodachrome™ slide film (or equivalent) is recommended because the dyes in it are more stable than other types and the photos retain the true colors longer (Jones 1992). Slides are valuable for use in slide presentations for groups. High quality prints made from the slides can be used in files and for other needs.

A neutral gray card (18 percent gray) (Appendix C) may be used to identify the photo point in the picture and help obtain true colors from film processing. Gray ranging from 15 to 25 percent is acceptable (Jones 1992).

Intensive Monitoring Sites

On intensive monitoring sites, take photographs upstream and downstream at cross-channel transect markers 1 and 11. (See Figure 1.) Take the photos from the side of the stream (document which side) that most effectively shows the important characteristics. Put a vegetation profile board (See Appendix E) or a range pole 50 feet (15 meters) from the photo point within three feet of the water's edge for the upstream photos. Using a range pole or vegetation profile board improves the useability of the photo by providing a constant comparison of vegetation height and density.

Other Permanent Photo Points

Establish permanent photo points on streams to show management results, particular problems, or other purposes. Place a permanent marker, such as a steel post, that is not likely to be destroyed or moved and that may be found with relative ease. Take photos upstream and downstream from the photo point. Remember, someone other than the original photographer will probably be take future pictures. Place the vegetation profile board or a range rod 50 feet (15 meters) from the photo point marker and within three feet of the water's edge.

STREAM/RIPARIAN EVALUATION

After completion of classification (Step 1, above), locate a reference site that matches the classification. This reference site serves as an index of desired future condition (DFC) and functions as a control during the monitoring period. Paired comparisons with the reference site will indicate changes in the managed site over time relative to natural changes (due to climate, for example). The reference site also establishes a baseline condition or site specific objective against which the impacted or treatment site can be evaluated to quantify its present condition.

Monitoring comparable treatment and reference sites is a very effective design. The reference site provides the data to separate the impact of treatment from the variability shared by both systems. As stated by Meals (1991), "...evaluation of NPS (nonpoint source) watershed projects can rarely be treated as a simple short-term before/after or above/below exercise." Statisticians require paired comparison for monitoring to control effects of climatic and hydrologic variability on stream/riparian conditions. Year-to-year variations in precipitation, for example, will obscure real changes in phosphorous export or substrate sedimentation over time. Using multiple references can also provide stronger statistical cause and effect evidence. This method is the most accurate and preferred for establishing objectives.

In the absence of a reference site, establish a DFC considering site potential, desired condition, and resource uses. Using a DFC does not provide for evaluating natural variables as does a reference site and is therefore less reliable. It does, however, provide site-specific objectives that assist with determining the present condition of the stream reach. Comparing the desired future condition with the present condition must be interpreted to define the effects of the BMPs and the natural variables.

Water quality on rangeland streams depends on a properly functioning riparian ecosystem (Chaney et al 1990). Riparian ecosystems result from the vegetation and hydrologic characteristics of the stream or water.

Describing the Resource Value Rating or Ecological Status

The degree of similarity between current green line vegetation and desired future condition determines the ecological status or resource value rating (USDA 1990 and USDI 1989).

Similarity values between the DFC and the present condition indicate the current condition status. Similarity values are expressed as a percentage of the DFC and is a resource value rating.

If the reference site or the established "desired future condition" is the "potential natural community," the condition is usually expressed as the ecological status.

Ecological status is based on the similarity or comparison of the present plant community to the potential natural community (PNC) (Clary and Webster 1989 and Myers 1989). Ecological status is shown on Table 1 (page 23).

It is important to remember that the condition of a riverine riparian area and ecological status are not equivalent. This concept is discussed in more detail later.

Table 1. Ecological Status

Similarity to PNC	Ecological Status
Less than 25	Early Seral
26 to 50	Mid Seral
51 to 75	Late Seral
76 plus	Potential Natural Community

Resource value ratings are used for vegetation when seral stages other than the potential natural community (PNC) are the desired future condition (Clary and Webster 1989 and Myers 1989). Resource value ratings are based on a comparison of the present vegetative communities to the desired future condition and are expressed as a percentage. They may also be used to evaluate green line vegetation, streambank stability, canopy closure, overhanging vegetation, and thermal input. Resource value ratings are expressed in terms of condition as shown in Table 2.

Table 2. Resource Value Rating

Condition Rating	Percent Similarity
Poor	less than 25
Fair	26 to 50
Good	51 to 75
Excellent	76 plus

The method for determining similarity is presented below for each parameter.

Table 3. Green Line Vegetation Composition.

The composition of green line vegetation is expressed as a percentage by community type. Calculate the percent similarity by adding the amount of treatment site community composition that is in common with the reference or site specific objective:

Vegetation Community Type	Desired Future Condition (%)	Treatment Site (%)	Amount in Common (%)
Booth willow (SABO)	45	10	10
Nebraska sedge (CANE)	35	5	5
Blue grass (POPR)	5	80	5
Booth willow/bluegrass	15	5	5
Totals	100	100	25

Similarity = 25%

Table 4. Woody Species Age Class

The results are expressed as the composition of shrubs by age class. As with green line vegetation composition, the evaluation of condition is in terms of total composition in common with the reference site:

Woody Species Age Class	Desired Future Condition (%)	Treatment Site (%)	Amount in Common
Sprouts	40%	5	5
Young	25	10	10
Mature	30	35	30
Decadent	5	20	5
Dead	0	30	0
Totals	100	100	50

Similarity = 50%

Table 5. Herbage Stubble Height

Calculate the average stubble height by adding the total height of the herbaceous vegetation measured and dividing by the number of plants measured. The dividend is expressed as the average stubble height in inches. This is compared to the standard established for the area.

Vegetation Species[1]	Total Height ÷	Total Plants =	Average Height
Blue grass (POPR)	204	34	6"
Juncus (JUBA)	120	15	8"
Water sedge (CAAQ)	52	26	2"
Beaked sedge (CARO)	60	10	6"
Bluejoint Reedgrass (CACA)	60	15	4"
Average -	496	100	5"

[1] List may include common name, scientific name, and/or standard four or six character symbols or a combination of common name and symbols

Table 6. Twig Count

Utilization of woody species is determined by counting the number of twigs browsed and unbrowsed and dividing by the total number of twigs counted.

Woody Specie	Number Browsed	Number Unbrowsed	Total Counted	Percent Browsed
Salix exigua	30	55	85	35
Salix boothii	23	38	61	38
Totals	53	93	146	36

Table 7. Utilization - Ocular Estimate

Calculate average utilization using the ocular estimate method by multiplying the number of utilization estimates for each category by the midpoint number for the category (slight=10, light=30, moderate=50, heavy=70, and severe=90), adding the products and dividing by the total number of estimates.

	Slight	Light	Moderate	Heavy	Severe
Estimates	10	13	27	37	13
Mid-Point	X 10	X 20	X 50	X 70	X 90
Product	100	260	1350	2590	1170

3760 ÷ 100 = 37.6 or 38% average utilization, light use.

Table 8. Streambank Condition

Calculate the composition of the streambank for each of the four streambank condition classes and express as a percentage by class. Similarity is the total percentage that the present condition has in common with the desired future condition. The following example illustrates the calculation of "common" values:

Condition Class	Desired Future Condition	Treatment Site	Amount in Common
> 50% cover/stable	87%	40	40
> 50% cover/unstable	5	25	5
< 50% cover/stable	8	10	8
< 50% cover/unstable	0	25	0
Totals	100	100	53

Similarity = 53%

Table 9. Canopy Cover

Canopy cover is expressed as the percentage of the water surface of a stream shaded by vegetation. The equation to find the similarity is--

$\%S = [\%Cr - (\%Cr - \%Ct)] / \%Cr \times 100$

Where: $\%S$ = % similarity or condition
$\%Cr$= % canopy cover at reference or DFC
$\%Ct$= % canopy cover at the treatment

$60\% = [48 - (48 - 29)] \div 48 \times 100$

60% = Good Condition (Table 2)

NOTE: Percent similarity exceeds 100 when the canopy cover at the reference or DFC is less than canopy cover at the treatment site.

Table 10. Overhanging Vegetation

Overhanging vegetation is expressed as the percent of streambank with overhanging vegetation. The equation for finding the similarity is--

$\%S = [\%Or - (\%Or - \%Ot)] / \%Or \times 100$

Where: $\%S$ = Percent similarity or condition
$\%Or$= Percent overhanging vegetation at reference or DFC
$\%Ot$= Percent overhanging vegetation at the treatment

$10\% = [52 - (52 - 5)] \div 52 \times 100$

10% is poor condition (Table 2)

NOTE: Percent similarity exceeds 100 when overhanging vegetation at the reference is less than the treatment site.

Table 11. Thermal Input

The output is in thousands of British thermal units (BTU) per unit area of stream. As with maximum temperature, thermal input is usually higher in treatment areas than in reference areas, thus--

$$\%S = [THr - (THt\text{-}THr)]/THr \times 100$$

Where: %S = Percent similarity or condition
THr = Thermal input at reference or DFC
THt = Thermal input at the treatment

$$53\% = [4950 - (7382 - 4950)] \div 4950 \times 100$$

53% is fair condition (Table 2)

NOTE: Percent similarity exceeds 100 when thermal input at the reference is greater than at the treatment site.

Evaluating Riverine Riparian Area Health

Healthy riverine riparian ecosystems protect beneficial uses of water, slow flood water, filter sediment, reduce water temperature, protect streambanks, reduce erosion, and store water (Chaney 1990). In addition, they reduce the amount of stream channel changes resulting from catastrophic events, such as ice and extreme flooding. Understanding ecological succession on riverine riparian areas is important in determining the desired future condition of a site. Riparian ecosystems are dynamic, with both primary and secondary succession being an integral part in their functions. Erosion and deposition associated with fluvial processes can cause major changes in riparian communities in a short period of time (Hansen et al 1988).

Recently, the health of a plant community has been equated with the ecological status of the vegetation. This is not a practical view on riparian areas (USDI 1990) because the concept, as related to upland ecosystems, usually considers only secondary succession. Primary succession plays a major role in riverine riparian vegetative communities. Usually only small portions, if any, of the stream corridor reaches the potential natural community at any one point in time. Hydrologic functions of riverine riparian ecosystems is a major force that must be understood to understand the riparian ecosystem functions (Swanson 1988). Natural events, such as the introduction of beaver into an area or large trees falling into the stream, change the stream flow characteristics and stream channel, thus changing the riparian vegetation (Gebhardt n.d.). Catastrophic events (e.g., beaver dam failure, rain-on-snow storms, ice jams, ice flows, debris dam failures) cause profound changes in vegetation along a stream channel in a short period of time.

Site Progression

Since riverine riparian systems are dynamic, it is important to understand the potential pathways or progression that a site may undergo as a result of natural and man-caused events (USDI 1990). The concept of *site progression* recognizes that riparian communities at any stage of ecological succession, primary or secondary, may be healthy and functioning or unhealthy and not functioning (USDI 1990).

A particular site, such as the one shown in Figure 9, may proceed along many pathways. This example illustrates a willow association on a B4 stream type.

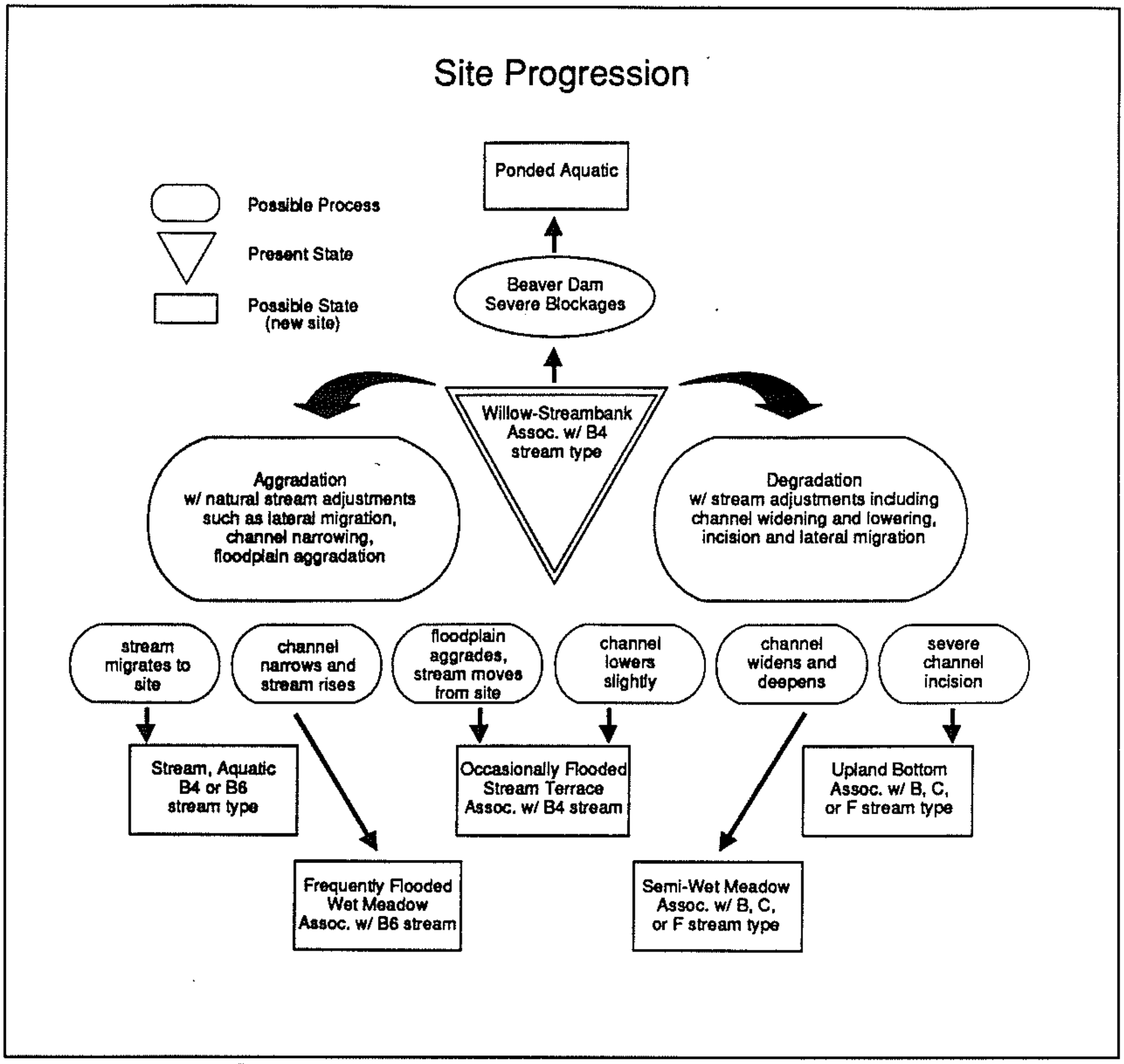

Figure 9. Concept of Site Progression (USDI 1990). The boxes represented as "states" may include many different site types and may be found associated with stream types (e.g., B4, C3), as described by Rosgen (1985).

Another classic example is the typical cottonwood community. Cottonwood is a pioneering species (occurs in primary succession). It requires barren, moist soils, such as newly formed point bars, to germinate and become established. After establishment, the new trees begin to collect fine sediment, and the environment changes. The community may persist and continue to establish along streams where flooding and deposition continue to occur. At this point, the cottonwood community is in primary stage of succession. But since it is functioning very well, it is a healthy system. In many cases, the cottonwood community is the desired future condition for a particular resource value (e.g., bald eagle habitat). Bald eagles are a listed threatened species, and maintaining their habitat has very high resource values. Over time, without flooding and deposition, a more stable plant community will replace a cottonwood stand, usually with a lower-growing willow or shrub community better adapted to self perpetuation. Thus, controlling flooding and sediment deposition lessens the opportunity for cottonwood communities to establish or re-establish, and the community deteriorates.

Riparian Area Health

The health of a riparian area, in relation to the beneficial uses of water, requires that several factors be considered for rangeland streams. The major pollutants limiting beneficial uses of water are sediment (usually from streambank erosion) and elevated water temperatures (generally caused by a lack of vegetative canopy cover) (IDHW 1989).

Streambank (green line) vegetation provides for stable streambanks and fish habitat. It is generally the first factor to respond to management changes and indicates the health and stability of the vegetative community. Streambank stability measures the physical condition of the streambank and streambank erosion. Woody species age class provides an assessment of the amount and health of the woody vegetation along a stream. Healthy woody vegetation along the streambank reduces water temperatures by shading water's surface and maintains stable streambanks. Canopy cover, overhanging vegetation, or solar input are methods of measuring how effectively vegetation is shading the water's surface.

Riparian Health Index

The Riparian Health Index (RHI) is a composite of the four factors described above and their effects on water quality. Woody species age class is deleted from the formula when woody species are not part of the site potential or desired future condition. In those cases, overhanging herbaceous vegetation and streambank stability are critical to the relative health of the riverine riparian system.

Table 12. Riparian Health Index

$$RHI = GLs + SSs + WSs + CCs / 4$$

Where: RHI = Riparian Health Index

GLs = % similarity for Green Line Vegetation (See Table 3.)

SSs = % similarity for Streambank Stability (See Table 7.)

WSs = % similarity for Woody Species Age Class (See Table 4.)

CCs = % similarity for Canopy Closure, Overhanging Vegetation, or Thermal Input (See Tables 8, 9, or 10.)

Example using the information from Tables 3 through 8, pages 26 to 29:

RHI = GLs + WSs + SSs + CCs / 4
41 = 25 + 50 + 53 + 37 / 4

Based on the Resource Value Rating, an RHI of 41 is poor condition (Table 2).

Describing Treatment Effects Over Time

Several statistical methods are recommended for assessing treatment effects or trends over time. Detailed descriptions of these methods are not repeated here. Refer to a good environmental pollution monitoring statistical methods text such as Gilbert (1987) for the specific equations and testing approaches.

The simplest approach is time regression. Using this technique, the slope of a regression line of percent similarity of each parameter against time is tested. A significant slope is indicative of trend.

An effective approach is the paired regression suggested by Meals (1991). A regression relationship between treatment and reference sites is developed prior to treatment (calibration relationship). After application of nonpoint source controls, a similar regression is derived, and significant difference in slope between the two regressions indicates the effects of treatment.

Non-parametric techniques allow for comparing percent of similarity at different times and places. Tests do not require that data follow the normal (or any other) distribution. Also, the tests allow for the inclusion of missing data. Some of the more commonly applied techniques are the seasonal Kendall, Mann-Whitney, and Spearman rank tests.

Quality Assurance

Controlling the quality of data obtained from these protocols depends on the consistency of those reading the field data from site-to-site and year-to-year. It is important that an interdisciplinary team consisting of individuals having good knowledge of soils, hydrology, fish habitat, and riparian plant identification and ecology establish and evaluate the monitoring sites. Proper training in the use of these protocols is essential to the quality and consistency of the data. Equipment should be calibrated and maintained on a regular basis.

At least 10 percent of the sites should be read a second time within one week of the original data collection. This may be by the same observer or another observer. The two observations are compared and consistency determined. Statistical analysis may be used to determine if significant differences have occurred. This procedure may be used to verify the validity of the data collected.

GLOSSARY

Bankfull Width. The channel width is the portion of the channel within the bounds of perennial streamside vegetation, typically defined by the mean annual high flow.

Cobble Embeddedness. The degree to which cobbles are surrounded or covered by fine sediment (sand or silt), usually expressed as a percentage.

Confinement. The relationship of a channel to the valley walls or terrace. It describes how restrictive the valley's walls are in limiting the channel's lateral movement (meandering).

Cross-channel Transect. A permanently marked linear plot across a stream channel that is perpendicular to the thalweg of a stream. The transect is marked on either side of the stream and above the bankfull level.

Desired Future Condition (DFC). The resource condition or site-specific objectives, based on the resource values wanted. The DFC must be based on the potential of the site to produce that resource value or condition.

Ecological Status. The degree of similarity or comparison between current vegetation and the potential natural community (PNC) for the site.

Entrenchment. The relation of the channel to the valley flat or floodplain, i.e., downcutting, incising. (See Appendix B, page B - 8)
Forage. The part of the vegetation that is available and acceptable for animal consumption, usually herbaceous and shrub species.

Green Line. The first perennial vegetation above the stable low water line of a stream or water body.

Habitat Attribute. An element used to describe a habitat unit, i.e. length, bankfull depth, substrate size, streambank conditions.

Habitat Unit. A run, riffle, pool, or glide along a stream.

Intensive Monitoring Site or Monitoring Site. A site within a stream sub-area selected to represent the sub-area for collecting detailed water quality data (i.e., vegetation, water chemistry, temperature, dissolved oxygen).

Intermontane. Stream within a forested mountainous area.

Left Bank. The left hand side of the stream looking downstream.

Overhanging Vegetation. Live plants (graminoids, forbs, shrubs, and trees) that extends over the stream at least 12 inches from the bank and within 12 inches of the water's surface at stable low flow.

Plant Succession. The process of vegetational development in which plant communities progress from a lower to a higher ecological status.

Primary Forage. Vegetation preferred by grazing animals.

Primary Succession. The initial establishment of vegetation on bare surfaces not previously vegetated, such as a recently deposited point bar.

Potential Natural Community (PNC). The combination of plant species that would result if ecological succession was completed without interruption.

Right Bank. The right hand side of the stream looking downstream.

Resource Value Rating (RVR). The degree of similarity of the existing resource conditions (vegetation, habitat, streambanks, etc.) to the future desired condition.

Representative Reach. A portion of a stream that contains characteristics similar to a larger segment that it represents.

Riverine. Relating to or resembling a river or stream.

Stream Order. A system of ranking a stream and its tributaries from the headwaters to its mouth. The ranking is expressed as a number from 1 to 7. Order one streams are the highest in the watershed and have not tributaries. The junction of two order one stream create an order two stream. The joining of two order two streams create an order three stream. This system continues down the stream to its terminus.

Secondary Succession. The sequence or progression of plant communities from a disturbed state or condition (e.g. fire, livestock grazing, flooding, ice, drought) toward the potential natural community.

Salmonid. Any species of fish from the family Salmonidae.

Sinuosity. The ratio of the channel length to the valley length.

Stream Meander Cycle. One full cycle of typical hydraulic (habitat) units (i.e., one pool and one riffle/glide). A stream meander cycle is usually over a stream distance that is 5 to 7 times the bankfull width.

Stream Reach. A subdivision of a stream segment, usually described by an EPA Stream Reach Number.

Stream Segment. A part of a stream described by a PNRS number.

Stream Type. A stream classification system based on a combination of stream entrenchment, sinuosity, gradient, width/depth ratio, confinement, and soil/land/form.

Sub-area. The smallest stream subdivision described in a reconnaissance level inventory. It is based on geology, gradient, soils, vegetation, land use, land ownership, and stream order.

Substrate Embeddedness. See cobble embeddedness.

Thalweg. A line connecting the deepest parts of a stream.

Utilization. The amount (expressed as a percentage or level, light, moderate, heavy, or severe) of vegetation removed by a grazing animal, including but not limited to elk, deer, moose, antelope, cattle, sheep, horses, and goats.

Witness Marker. A steel post, marked fence post or tree, mound of rocks, or other appropriate device used to monument for relocating permanent photo points or cross-channel transects.

Woody Species. Plant species classified as shrubs or trees.

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APPENDIX A

BASIC LEVEL INFORMATION

1. Basic Level Data Sheet
2. Instructions for Basic Level Data Sheet
3. Listing of Existing Data
4. Instructions for Listing of Existing Data

1. BASIC INFORMATION DATA SHEET

Stream Name: ______________________ Date: ____________

Sub-Area: ________ EPA No. ______________ PNRS No.: ________

Maps: ______________________ Photos: ________________

Information Collected by: ______________ Agency: ______________

Geomorphic Setting:

Stream Order: ____ Gradient: ____ Valley Bottom Type: ____ Aspect: ____

Elevation: Upper ________ Lower: ________ Entrenchment: ________

Sinuosity: ______ Dominant Substrate: ______ Stream Type (Rosgen): ______

Size: Length ____________ (Miles or Feet) Area ____________ (Acres)

Landform: ____

Geology and Soils:

Geologic Parent Material: ________________________________

Soil Mapping Units:

<u>Mapping Unit Nos.:</u> <u>Soil Family Name:</u>

__________ ______________________________

__________ ______________________________

Dominant Vegetation:

____ Conifer ____ Deciduous ____ Shrub ____ Herbaceous/Graminoid ____ Non-vegetated

Dominant Land Use(s): ________________________________

____

Comments:

2. INSTRUCTIONS FOR THE BASIC INFORMATION DATA SHEET

Stream Name: Name of the stream or stream segment described.

Date: Date information collected.

PNRS No. Pacific Northwest River Study numbering system used by DEQ in antidegradation and water quality assessment reports.

EPA No.: EPA Stream Reach Number based hydrologic units. This is the preferred numbering system.

Stream Segment Length: The length in miles of the stream segment described on the data sheet.

Area Size: Riparian area size associated with the stream reach.

Quad(s): List the U.S.G.S. topographic maps used.

Aerial Photo(s): List the aerial photos used.

Information Collected By: List the individual(S) collecting the data.

Agency: List agency responsible for data.

Stream Order: The stream order for the reach described.

Gradient: The gradient of the stream segment described, obtain the information from topographic maps.

Valley Bottom Type: The valley bottom type described in Appendix B.

Aspect: The general aspect of the stream reach described.

Elevation: The upper and lower elevation of the stream reach.

Entrenchment: The degree to which the stream is confined to the stream channel, see Appendix B.

Sinuosity: The stream channel length divided by the valley bottom length.

Dominant Substrate: The stream bed substrate inferred from existing information, e.g. soil survey, stream surveys.

Stream Type: The Rosgen stream type as described in Appendix B. Usually must be completed after the Reconnaissance level inventory.

Parent Material: List the major parent materials that effect the stream.

Landform: Provide thē land form from the soil survey or describe the land form.

Soil Mapping Units: List the dominant soil mapping unit for the riparian areas.

Soil Family Name: List the name of the soil family.

Dominant Vegetation: Mark the apparent dominant vegetation along the stream.

Dominant Land Use: Describe the major land use activities affecting water quality.

3. REVIEW OF EXISTING DATA

Stream Name:____________________ EPA Stream Reach No.__________

Compiled by: ____________________ Date: __________

Maps and Aerial Photos Available:

Name	Type & Scale

Water Quality (Chemical & Physical):

Report Name	Source	Location

Fish and Macroinvertebrates:

Soils and Vegetation:

Stream Flow and Other Stream Parameters:

Other

4. INSTRUCTIONS FOR EXISTING DATA LISTING

Stream Name: Provide the name of the stream segment basic information listed.

EPA No.: EPA Stream Reach Number based on the hydrologic region.

Compiled by: Provide the name(s) of the individuals compiling the data.

Date: Date of data compilation.

Type: List the type of map and/or aerial photos, i.e. orthophoto, topographic.

Scale: Provide the scale of the map or aerial photo, i.e. 1" = 1 mile, 1:20,000.

Source: List the agency that produced the report.

Location: List the Location of the report or data.

Existing resource information is important to assist in assessing water quality. It can save duplication of effort, provide baseline data, and guide future inventory and monitoring efforts. This form provides a listing of various types of existing inventory and monitoring data, source of the information, and the location of the data.

1. VALLEY BOTTOM TYPE

VALLEY FORM:

U-Shape	1000	
V-Shape	2000	
Trough-Like	3000	
Flat Bottom	4000	
Box Canyon	5000	

VALLEY BOTTOM GRADIENT:

Very Low	< 2%	100
Low	2 - 4%	200
Moderate	>4 - 6%	300
High	>6 - 8%	400
Very High	>8%	500

VALLEY BOTTOM WIDTH:

Very Narrow	< 10 m	10
Narrow	10 - 30 m	20
Moderate	30 - 100 m	30
Broad	100 - 300 m	40
Very Broad	>300 m	50

VALLEY SIDE SLOPES:

Low	< 30%	1
Moderate	30 - 60%	2
Steep	> 60%	3

Example:

Flat Bottom (4000), Low Gradient (200), Narrow Valley (20), and Low Side Slopes (1) =

Typical Code 4221

2. KEY TO CLASSIFICATION OF NATURAL STREAMS (Rosgen 1992)

Channels	SINGLE THREAD CHANNEL						MULTIPLE CHANNELS	
Entrenchment *	High (< 1.4)			Moderate (1.4-2.2)	Slight (> 2.2)		N/A	
Width/ Depth **	Low (> 12)		Mod.-High (> 12)	Moderate (> 12)	Very Low (< 12)	Mod.-High (> 12)	Very High (> 40)	
Sinuosity *	Low (< 1.2)	Moderate (> 1.2)	High (> 1.4)	Moderate (> 1.2)	Very High (> 1.5)	High (> 1.4)	Channel Unstable	Channel Stable
Channel Type	**A** p B - 2	**G** p B - 3	**F** p B - 3	**B** p B - 4	**E** p B - 4	**C** p B - 5	**D** p B - 5	**DA** p B - 5

* Values may vary by ± 0.2 units.

** Values may vary by ± 2.0 units.

A - CHANNEL TYPES

Entrenchment--High < 1.4 (geologically confined by steep side slopes or terraces)
Width/Depth Ratio--Low < 12
Sinuosity--Low < 1.2

Dominant Substrate	Gradient (%) Channel Type	
	4 to 9.9 %	> 10 %
Bedrock	A1	A1a+
Boulder	A2	A2a+
Cobble	A3	A3a+
Gravel	A4	A4a+
Sand	A5	A5a+
Silt/Clay	A6	A6a+

"A" channels are generally steep slope, well confined geologically sidewalls or terraces.

G - CHANNEL TYPES

Entrenchment--High < 1.4 (channel incised, gully) Width/Depth Ratio--Low < 12 Sinuosity--Moderate > 1.2		
Dominant Substrate	Gradient (%) Channel Type	
	2 to 3.9 %	< 2 %
Bedrock	G1	G1c
Boulder	G2	G2c
Cobble	G3	G3c
Gravel	G4	G4c
Sand	G5	G5c
Silt/Clay	G6	G6c

"G" channels are usually incised, well confined as a result of the down cutting and are considered gullies.

F - CHANNEL TYPES

Entrenchment--High < 1.4 Width/Depth Ratio--Moderate to High > 12 Sinuosity--High > 1.4			
Dominant Substrate	Gradient (%) Channel Type		
	< 2 %		2 to 3.9 %
Bedrock	F1		F1c
Boulder	F2		F2c
Cobble	F3		F3c
Gravel	F4		F4c
Sand	F5		F5c
Silt/Clay	F6		F6c

"F" channels are incised, wide flat bottomed, steep side channels.

B - CHANNEL TYPES

Entrenchment--Moderate < 1.4 to 2.2 (channel geologically confined)
Width/Depth Ratio--Moderate > 12
Sinuosity--Moderate > 1.2

Dominant Substrate	Gradient (%) Channel Type		
	2 to 3.9 %	< 2 %	4 to 9.9 %
Bedrock	B1	B1a	B1c
Boulder	B2	B2b	B2c
Cobble	B3	B3b	B3c
Gravel	B4	B4b	B4c
Sand	B5	B5b	B5c
Silt/Clay	B6	B6b	B6c

"B" channels are moderately steep, moderately confined by steep slopes and terraces.

E - CHANNEL TYPES

Entrenchment--Slight, > 2.2
Width/Depth Ratio--Very Low, < 12
Sinousity--Very High, > 1.5

Dominant Substrate	Gradient (%) Channel Type		
	< 2 %		2 to 3.9 %
Bedrock			
Boulder			
Cobble	E3		E3b
Gravel	E4		E4b
Sand	E5		E5b
Silt/Clay	E6		E6b

"E" channels are usually narrow, deep crooked streams found in meadows.

C - CHANNEL TYPES

Entrenchment--Slight, > 2.2 Width/Depth Ratio--Moderate to High, > 12 Sinuosity--High, > 1.4			
Dominant Substrate	Gradient (%) Channel Type		
	2 to 3.9 %	0.1 to 2 %	4 to 9.9 %
Bedrock	C1b	C1	C1c
Boulder	C2b	C2	C2c
Cobble	C3b	C3	C3c
Gravel	C4b	C4	C4c
Sand	C5b	C5	C5c
Silt/Clay	C6b	C6	C6c

"C" channels are typically low gradient streams, unconfined with high sinuosity.

MULTIPLE CHANNELS

Width/Depth Ratio--Very High, > 40			
Dominant Substrate	Stable Channel		Unstable Channel
	Gradient (%) Channel Type		Gradient (%) Channel Type
	2 to 3.9 %	< 2 %	4 to 9.9 %
Bedrock			
Boulder			
Cobble	D3b	D3	
Gravel	D4b	D4	DA4
Sand	D5b	D5	DA5
Silt/Clay	D6b	D6	DA6

3. STREAM CHANNEL CLASSIFICATION DEFINITIONS

Entrenchment--the ratio of the flood zone width, at two times the bankfull depth, divided by the bankfull width. Measurements are made on site.

Gradient--the percent slope of the water surface. Measurements may be made from topographic maps or on site.

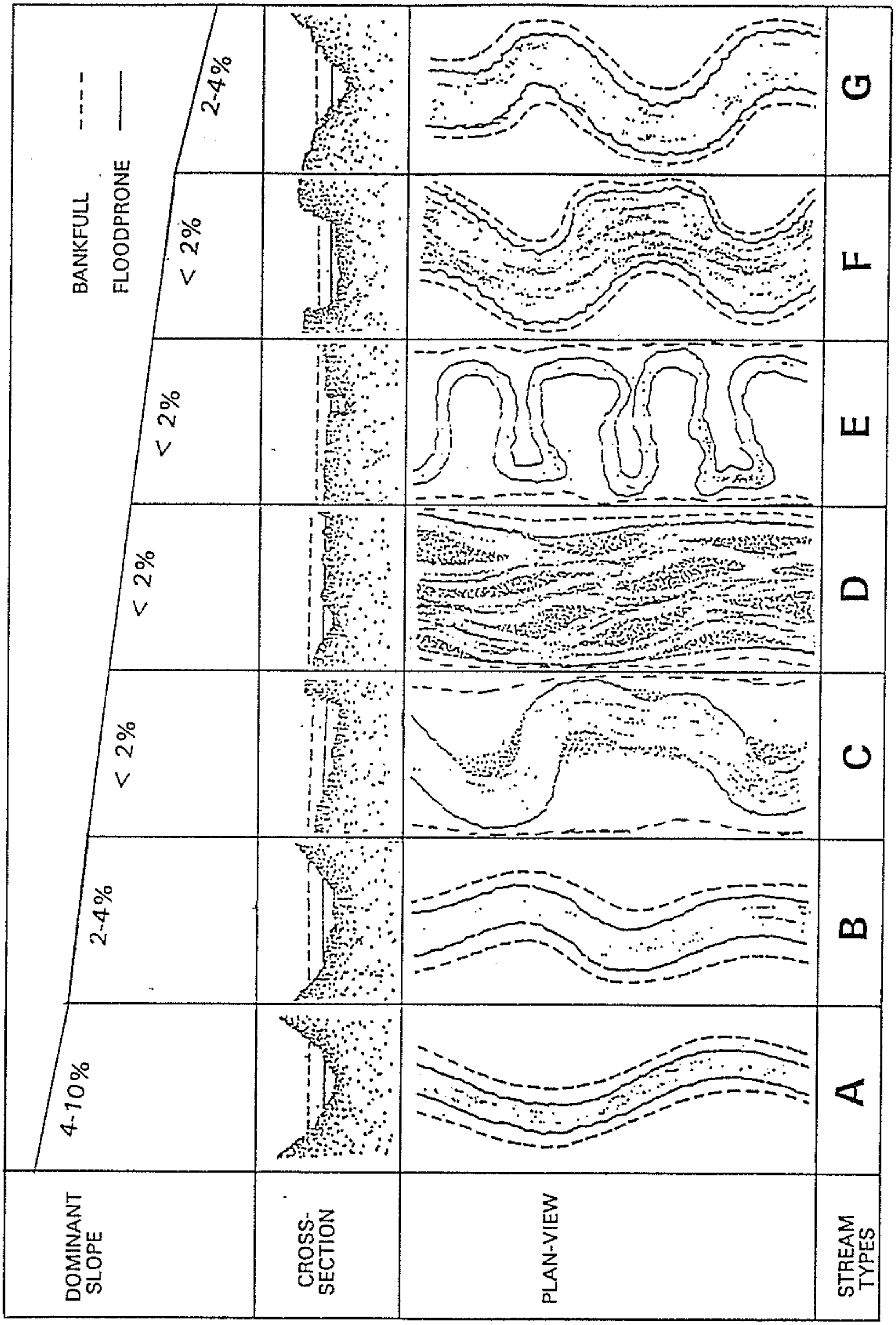
Sinuosity--the stream channel length divided by the valley length. Measured from a topographic map or on site.

Width/Depth (W/D) Ratio--the bankfull width divided by the bankfull depth. Measurement is made on site.

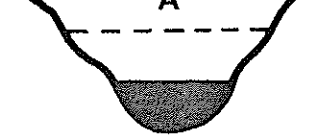
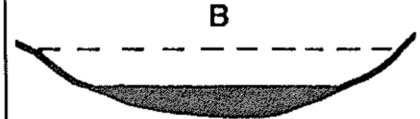
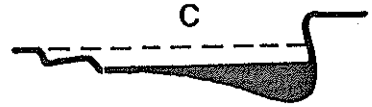
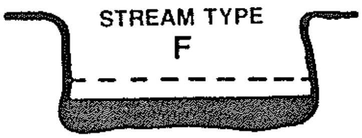
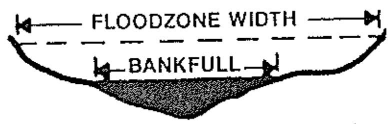
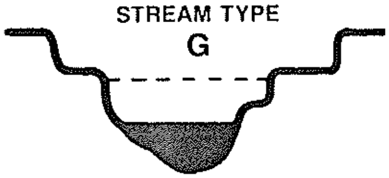
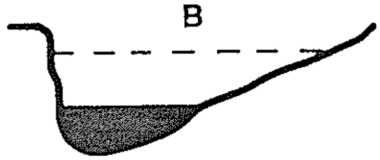
Dominant substrate--the size of most of the bottom particles or material in a streambed. Substrate in the stream is estimated or measured using a Wolman pebble count. Measurements or estimates are made in the field.

Confinement--the amount of lateral movement a stream channel can make as a result of geologic structures such as valley walls or terraces.

4. MAJOR STREAM TYPES (Rosgen 1992)



5. STREAM ENTRENCHMENT (Rosgen 1992)

ENTRENCHED	MODERATELY ENTRENCHED	NOT ENTRENCHED
STREAM TYPE A 	STREAM TYPE B 	STREAM TYPE C 
STREAM TYPE F 	 ET RATIO = FZ WIDTH/BKF WIDTH	STREAM TYPE D 
STREAM TYPE G 	STREAM TYPE B 	STREAM TYPE E 
< 1.4	1.41 to 2.2	> 2.2
	ENTRENCHMENT RATIO	

Flood zone width, the width of the flooded zone channel at two times the bankfull depth.

6. DELINEATIVE CRITERIA FOR STREAM SUB-TYPES (Rosgen 5/91)

STREAM SIZE(S)

S-1	Bankful width less than 1 foot
S-2	Bankfull width 1-5 feet
S-3	Bankfull width 5-15 feet
S-4	Bankful width 15-30 feet
S-5	Bankfull width 30-50 feet
S-6	Bankfull width 50-75 feet
S-7	Bankfull width 75-100 feet
S-8	Bankfull width 100-150 feet
S-9	Bankfull width 150-250 feet
S-10	Bankfull width 250-350 feet
S-11	Bankfull width 350-500 feet
S-12	Bankfull width 500-1,000 feet
S-13	Bankfull width 1000 feet +

ORGANIC DEBRIS/CHANNEL BLOCKAGES
(In Active Channels)

D-1	None
D-2	Infrequent debris, what's present consists of small, floatable
D-3	Moderate frequency, mixture of small to medium size debris affects less than 10% of active channel area.
D-4	Numerous debris mixture of medium to large sizes - affecting up to 30% of the area of the active channel.
D-5	Debris dams of predominantly large material affecting over 30% to 50% the channel area and often occupying the total width of the active channel.
D-6	Extensive, large debris dams either continuous or influencing over 50% of the channel area. Forces water onto flood plain even with moderate flows. Generally presents a fish migration blockage.
D-7	Beaver dams - few and/or infrequent. Spacing allows for normal streamflow conditions between dams.
D-8	Beaver dams - frequent. Back water occurs between dams - stream flow velocities reduced between dams.
D-9	Beaver Dams - abandoned where numerous dams have filled in with sediment and are causing channel adjustment of lateral migration, evulsion, and degradation, etc.
D-10	Man made structures - diversion dams, low dams controlled by-pass channels, baffled bed configuration with gabions, etc.

DEPOSITIONAL FEATURES (BARS)

B-1	Point Bars
B-2	Point Bars with Few Mid Channel Bars
B-3	Many Mid Channel Bars
B-4	Side Bars
B-5	Disposal Bars
B-6	Main Branching with Many Mid Bars and Islands
B-7	Mixed Side Bar and Mid Channel Bars, Exceeding 2-3% Width
B-8	Delta Bars

RIPARIAN VEGETATION

V-1 Rock

V-2 Bare soil, little or no vegetative cover

V-3 Annuals and/or forbs

V-4 Grass - perennial bunch grasses

V-5 Grass - sod formers

V-6 Low brush species

V-7 High brush species

V-8 Coniferous trees

V-9 Deciduous trees

V-10 Wetlands

- a. Bog
- b. Fen
- c. Marsh

NOTE: Combinations of grass and brush understories with a coniferous overstory can be designated by combining sub-type numbers, i.e. (V4, 7, 8).

Subscript letters may be used to identify specific vegetative associations, speciation, habitat types, or riparian types based on level of detail required by stream type user.

FLOW REGIMEN

General Category

E. Ephemeral stream channels - flows only in response to precipitation.

S. Subterranean stream channel - flows parallel to or near the surface for various seasons -a sub-surface flow which follows the stream channel bed.

I. Intermittent stream channel - one which flows only seasonally, or sporadically. Surface sources involve springs, snow melt, artificial controls, etc.

P. Perennial stream channels - surface water persists year-long.

Specific Category

1. Seasonal variation in streamflow dominated primarily by snowmelt runoff.
2. Seasonal variation in streamflow dominated by stormflow runoff.
3. Uniform stage and associated streamflow due to spring fed condition, backwater, etc.
4. Streamflow regulate by glacial melt.
5. Streamflow regulated by a diversion, dam release, dewatering, etc.

MEANDER PATTERNS

M-1 Regular Meander

M-2 Tortuous Meander

M-3 Irregular Meander

M-4 Truncated Meander

M-5 Unconfined Meander Scrolls

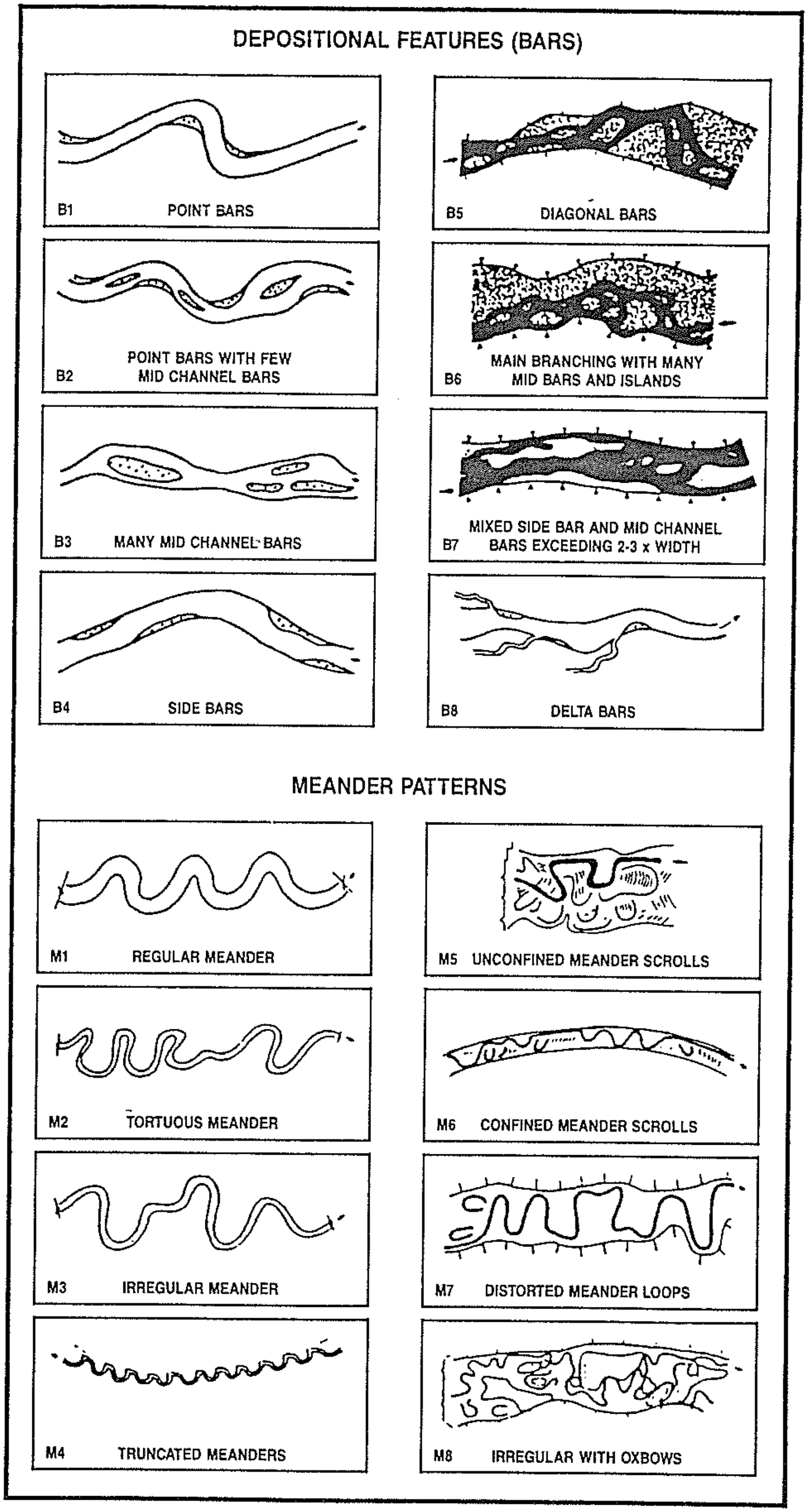
M-6 Confined Meander Scrolls

M-7 Distorted Meander Scrolls

M-8 Irregular with Oxbows, Oxbow Cutoffs

7. SUB-TYPE DEPOSITIONAL FEATURES AND MEANDER PATTERNS

(Rosgen 1985)



8. DEFINITIONS OF AQUATIC COMMUNITY HABITAT TYPES

A habitat type as used here is a unit of stream having a unique structure and function important to fish. There are two subdivisions of habitat types: Macro- and Micro- habitat types. Micro-habitats are distinct units of the stream whose length is less than one channel width and whose width is less than one-half channel width. All distinct units larger than this are considered macro-habitats.

The definitions were derived from: Western Division, American Fisheries Society (1985), Platts, Megahan, and Minshall, 1983, and Bisson and others (1981). These are sources frequently cited for habitat definition and characterization.

I. POOL

- An area of the stream that has reduced water velocity
- Water depth is deeper than surrounding areas
- The water surface gradient at low flow is often near zero
- The bed is often concave in shape and forms a depression in the thalweg profile
- Pools are formed by features of the stream that cause local deepening of the channel. This results from lateral constrictions in flow or by sharp drops in the water surface profile. They include:
    - Plunge pool created by water passing over or through a complete or nearly complete channel obstruction, scouring out a basin below. They are often associated with large debris and are usually macro-habitat
    - Dammed pools impounded upstream of a complete or nearly complete channel blockage caused by log jams, beavers, rockslides, boulders, etc. They are usually macro-habitat
    - A meander or corner pool is a lateral scour pool resulting from a sudden shift in channel direction and occurs along the outcurves of channel meanders. These are usually macro-habitat.
    - Backwaters caused by an eddy along the channel margin or by back-flooding upstream form an obstruction such as large woody debris, boulders, root wads, etc. - usually micro-habitat
    - Trenches or slot-like depressions formed usually in bedrock channels in long linear shapes - usually micro-habitat
    - Lateral scour around local obstructions such as wing deflectors, boulders, individual logs, etc - usually micro-habitat

II. RIFFLE

- Water flows faster than surrounding stream area
- Water is shallower than surrounding stream (< 20 cm or .6 ft in depth)
- Water surface is agitated relative to the surrounding stream
- Water surface gradient is steeper than the surrounding stream

There are three types of riffles:

- Low gradient: Water is shallow (< 20 cm or .6 ft deep), water velocity is moderate at 20-50 cm/sec, water surface gradient is less than 4% and water flows mostly on gravel or cobble substrate.

- Rapids: Water is swiftly flowing (> 50 cm/sec), turbulence is considerable, water surface gradient is greater than 4%, and substrate is mostly boulders or cobbles.
- Cascades: A series of steps or small waterfalls associated with bedrock or boulders. There is considerable water surface gradient, and small plunge pools may be associated with the type.

III. GLIDE

- Too shallow to be pool (< 30 cm deep, and too slow to be a run (< 20 cm/sec)
- Water surface gradient is nearly zero
- No pronounced turbulence on the water surface
- Substrate is typically gravel and cobble

As micro-habitat, glides usually occur at the downstream transition between pools and riffles. As macro-habitat, glides occur in long, low gradient stream reaches with stable banks and no large flow obstructions.

IV. RUN

- Too deep to be a riffle (> 30 cm deep), and too fast to be a pool (> 20 cm/sec)
- No pronounced water surface agitation
- The slope of the water surface is roughly parallel to the overall stream reach gradient
- Substrate is typically gravel and cobble

Glides are micro-habitats that usually occur at the downstream transition between pools and riffles and along the length of gradual channel constrictions where deepening is not associated with bed scour or bed depressions.

V. POCKET WATERS

- An area of stream forming a series of small pools surrounded by swiftly flowing water
- The small pools form behind boulders, rubble, or logs and create shallow habitats where fish feed and rest away from faster waters surrounding the pockets
- Distinguished from riffles by the prevalence of small pools associated with the type

9. SUGGESTED RIPARIAN PLANT IDENTIFICATION KEYS AND RIPARIAN COMMUNITY TYPE GUIDES

Brunsfeld, S.J. and F.D. Johnson. 1985. Field guide to the willows of east-central Idaho. Forest, Bulletin Number 39, Wildlife and Range Experiment Station, University of Idaho. Moscow, ID.

Cronquist, A., A.H. Holmgren, N.L. Holmgren, and J.L. Reveal. 1986. Intermountain flora, vascular plants of the intermountain west, U.S.A. Volumes 1 through 6. The New York Botanical Garden. Bronx, NY.

Hansen, P.L., S.W. Chadde, and R.D. Pfister. 1988. Riparian dominance types of Montana. Miscellaneous Publication No. 49. Montana Riparian Association. University of Montana. Missoula, MT.

Hansen, P., K. Boggs, R. Pfister, and J. Joy. 1991. Classification and management for riparian and wetland sites in Montana (draft version 1). Montana riparian Association. Montana Forest and Conservation Experiment Station. School of Forestry. University of Montana. Missoula, MT.

Herman, F.J. 1970. Manual of the carices of the Rocky Mountains and Colorado basin. Agricultural Handbook No. 374. USDA, Forest Service. Washington, DC.

Herman, F.J. 1975. Manual of the rushes (Juncus spp.) of the Rocky Mountains and Colorado basin. USDA, Forest Service. General Technical Report RN-18. Rocky Mountain Forest and Range Experiment Station. Fort Collins, CO.

Hitchcock, A.S. 1971. Manual of the grasses of the United States, Volumes one and (second edition) two. Dover Publications, Inc. New York City, NY.

Hitchcock, L.C. and A. Cronquist. 1973. Flora of the pacific northwest. University of Washington Press. Seattle, WA.

Hitchcock, C.L., A Cronquist, M. Ownbey, and J.W. Thompson. 1977. Vascular plants of the pacific northwest, volumes I - V. University of Washington Press. Seattle, WA.

Kovalchik, B.L. 1987. Riparian zone associations, Deschutes, Ochoco, Fremont, and Winema National Forest. R6-ECOL-TP-279-87. USDA, Forest Service, Pacific Northwest Region. Portland, OR.

Kovalchik, B.L., W.E. Hopkins, and S.J. Brunsfeld. 1988. Major indicator shrubs and herbs in riparian zones on national forests of central Oregon. R6-ECOL-TP-005-88. USDA, Forest Service. Pacific Northwest Region. Portland, OR.

Manning, M.E. and W.G. Padgett. 1992. Riparian Community Type Classification for the Humbold and Toiyabe National Forests, Nevada and Eastern California (Draft). USDA, Forest Service, Intermountain Station. Ecology and and Classification Program. Ogden, UT.

Padgett, W.G., A.P. Youngblood, and A.H. Winward. 1989. Riparian community type classification of Utah and southeastern Idaho. USDA, Forest Service. Intermountain Region. Ogden, UT.

Youngblood, A.P., W.G. Padgett, and A.H. Winward. 1985. Riparian community type classification of eastern Idaho--western Wyoming. R4-ECOL-85-01. USDA, Forest Service. Intermountain Region. Ogden, UT.

10. RECONNAISSANCE - RIPARIAN CLASSIFICATION

Stream Name: ____________ Sub-Area: ____________ Date: ____________

Agency: ____________ PNRS No.: ____________ EPA No.: ____________

Map Name: ____________ Examiner(s): ____________

Stream and Valley Bottom Classification:

Valley Bottom Type: ____________ Gradient: ____________ Aspect: ____________

Elevation: Upper ____________ Lower ____________ Middle ____________

Complex Size: Length ____________ Width ____________ Area ____________

Confinement: ____________ Sinuosity: ____________ Stream Type: ____________

SOILS

Dominant Soil Family(ies)	% Sub-area	Compaction
		Sl / Md / Sv
		Sl / Md / Sv
		Sl / Md / Sv

VEGETATION DESCRIPTION: DOMINANCE BY COMMUNITY TYPES

Community Type	% Sub-area	Potential Community Type

ADJACENT (non-riparian) VEGETATION (looking down stream)

Left ____________ Right ____________

GREEN LINE (Hydric Vegetation) ____________% **PHOTO ID:** ____________

BEAVER No. Active Dams ____________ No. Inactive Dams ____________ Other ____________

LAND USE ACTIVITIES AND ESTIMATED INFLUENCE ON RIPARIAN AREA

Livestock	Irrig. Cropland	Dry Cropland	Mining	Timber	Roads	Recreation	ORV	Other

Stream/Riparian Classification: ____________

11. INSTRUCTIONS FOR PREPARING RECONNAISSANCE - RIPARIAN CLASSIFICATION

Stream Name: Provide the name of the stream segment being classified.

Sub-area: Provide the name and/or number for the complex. An individual form should be completed for each sub-area described on the Basic Information Data Sheet and other sub-areas defined during the reconnaissance inventory.

Date: Date data is collected.

Agency: List the agency responsible for the classification.

PNRS No.: List the Pacific Northwest River Study No. from DEQ listing.

EPA No.: List the EPA Stream Reach Number.

Examiner(s): List the names of the individuals obtaining the data.

Map Name: Provide the name(s) of the USGS topographic map or other map being used.

Valley Bottom Type: Valley bottom type for the sub-area. (See page B-1)

Gradient: Stream gradient for the specific sub-area.

Aspect: General aspect of the sub-area.

Elevation: Provide the upper, middle (if needed), and lower elevation of the sub-area.

Complex Size: The size of the sub-area (riparian zone); length in miles, width in miles, and the area in acres.

Confinement: How restrictive the valley walls or river terraces are to lateral movement (meander) by a stream channel. Use the following descriptions:

> **Confined** - Stream channel lateral movement is controlled by valley walls or terraces.
>
> **Moderately Confined** - Stream channel lateral movement is occasionally deflected by valley walls or terraces.
>
> **Unconfined** - Stream channel is not controlled by valley walls or terraces.

Sinuosity: The ratio of the channel length divided by the valley bottom length.

Stream Type: Rosgen stream type and stream size (see Appendix B).

Dominant Soil Family: List the dominant soil family(ies) in the Sub-area.

Percent of Area: Estimate the percentage (to the nearest 5 percent) of the area for each dominant soil family on the riparian area.

Compaction: Estimate the soil compaction resulting from land use activities for each soil family.

Community Type: List the dominant riparian communities on the stream associated riparian area. Use the Riparian Vegetation Inventory form to determine Riparian Community Type (see Appendix B).

% Sub-area: The percentage (to the nearest 5 percent) sub-area for each community type.

Potential Community Type: The name of the potential natural community.

Adjacent Vegetation: List the adjacent upland plant community for each bank, left and right (looking down stream).

Green Line: Estimate the percentage of the total green line (both banks) contain desirable hydric vegetation.

Beaver: Record the number of active beaver dams, inactive beaver dams, and other information concerning beaver activity in the Sub-area.

Land Use Activities: Circle the land use activities influencing the stream and riparian area. Estimate the relative influence; high, medium, or low.

Stream/Riparian Classification: The classification consists of the sub-area number, dominant soil family, stream type (Rosgen), and dominant vegetation community.

12. RIPARIAN VEGETATION INVENTORY

Stream Name: ______________________ Sub-area: ____________ Date: ____________

PNRS No.: ______________ EPA No.: ______________ Observer: ________________

Plant Name	Canopy Density (%)	Plant Name	Canopy Density (%)
GRASS & GRASSLIKE		**GRASS & GRASSLIKE**	
Agropyron trachycaulum	______	Danthonia intermedia	______
Agrostis scabra	______	Deschampsia caepitosa	______
Agrostis stolonifera	______	Distichlis spicata	______
Calamagrostis canadensis	______	Eleocharis palustris	______
Carex aquatilis	______	Eleocharis pauciflora	______
Carex buxbaumii	______	Elymus glaucus	______
Carex disperma	______	Elymus triticoides	______
Carex douglassii	______	Festuca idahoensis	______
Carex lanuginosa	______	Festuca ovina	______
Carex lasiocarpa	______	Glyceria striata	______
Carex limosa	______	Hordeum brachyantherum	______
Carex microptera	______	Hordeum jubatum	______
Carex muricata	______	Juncus balticus	______
Carex nebrascensis	______	Phalaris arundinacea	______
Carex praegracilis	______	Phleum pratensis	______
Carex rostrata	______	Phragmites australis	______
Carex saxatilis	______	Poa palustris	______
Carex scirpoidea	______	Poa pratensis	______
Carex scopulorum	______	Poa trivialis	______
Carex simulata	______	Scirpus acutus	______
______________	______	______________	______
______________	______	______________	______
______________	______	______________	______
SHRUBS		**SHRUBS**	
Artemesia cana	______	Salix geyeriana	______
Alnus incana	______	Salix glauca	______
Betula glandulosa	______	Salix lasiandra	______
Cornus sericea	______	Salix lasiolepis	______
Crataegeus douglasii	______	Salix lemmonii	______
Potentilla fruticosa	______	Salix lutea	______
Prunus virginiana	______	Salix monicola	______
Rhus aromatica	______	Salix planifolia	______
Ribe aureum	______	Salix scouleriana	______
Rosa woodsii	______	Salix wolfii	______
Salix bebbiana	______	Sarcobatus vermiculatus	______
Salix boothii	______	Symphoricarpos oreophilus	______
Salix drummondiana	______	Toxicodendron rydbergii	______
Salix exigua	______	______________	______
______________	______	______________	______
______________	______	______________	______
______________			
TREES		**TREES**	
Abies grandis	______	Larix lyalli	______
Abies lasiocarpa	______	Larix occidentalis	______
Acer grandidentatum	______	Picea engelmannii	______
Acer negundo	______	Picea glauca	______
Betula occidentalis	______	Picea pungens	______
Elaeagnus angustifolia	______	Pinus albicaulis	______
Juniperus scopulorum	______	Pinus contora	______

RIPARIAN VEGETATION INVENTORY
(Page 2)

Stream Name: ____________________ Sub-area: ____________ Date: ____________

Plant Name	Canopy Density (%)	Plant Name	Canopy Density (%)
TREES (Continued)		**TREES** (Continued)	
Pinus monticola		Populus tricocarpa	
Pinus ponderosa		Pseudotsuga menziesii	
Populus acuminata		Salix amygdaloides	
Populus angustifolia		Thuga plicata	
Populus fremontii		Tsuga heterophylla	
Populus tremuloides		Tsuga mertensiana	
FORBS		**FORBS**	
Aconitum columbiana		Ligusticum canbyi	
Actaea rubra		Ligusticum grayii	
Agastache urticifolia		Ligusticum tenuifolium	
Aralia nudicaulis		Mentha arvensis	
Artemesia scopulorum		Mertensia ciliata	
Asarum caudatum		Mertensia fraciscana	
Caltha leptosepala		Mitella breweri	
Cirsium arvense		Mitella pentandra	
Clintonia uniflora		Osmorhiza occidentalis	
Conium maculatum		Pedicularis groenlandica	
Coptis occidentalis		Polygonum bistortoides	
Cornus canadensis		Saxifraga odontoloma	
Disporum hookerii		Senecio sera	
Dodecatheon jeffreyi		Senecio triangularis	
Epilobium angustifolia		Smilacina stella	
Equisetum arvense		Streptopus amplexifolius	
Geranium richardsonii		Thalictrum fendleri	
Geranium viscossisimum		Thalictrum occidentale	
Gilium triflorum		Tiarella trifoliata	
Goodyera oblongifolia		Trautvetteria spp.	
Hackelia floribunda		Urtica dioica	
Hackelia micrantha		Veratrum californicum	
Hackelia patens		Viola glabella	
Heracleum lanatum		Viola obiculata	
Hydrophyllum fendleri		Xerophyllum tenax	
Iris missouriensis			

Riparian Community Type: ____________________

Potential Natual Community: ____________________

Classification Key Used: ____________________

Comments:

13. INSTRUCTIONS FOR RIPARIAN VEGETATION INVENTORY

The Riparian Vegetation Inventory form provides a list of some of the important riparian plant species found in Idaho. It provides a convenient method for recording information.

1. Determine the important riparian vegetation communities within the sub-area from maps, aerial photos, or soil survey information.
2. Mark or list all plant species present within the community.
3. Estimate or measure the percent canopy cover for each plant species.
4. Determine the appropriate riparian community type, riparian association, or habitat type from the references listed below for each important plant community.
5. List the key or source used to determine the appropriate riparian community description. If the type is not found, describe the riparian community.
6. Describe the potential natural community (PNC) for the classified community. Most of the descriptions are listed in the description of the community types in the publications listed below.

Riparian Community Type Keys:

Padgett, W.G., A.P. Youngblood, and A.H. Winward. 1989. *Riparian Community Type Classification of Utah and Southeastern Idaho.* USDA, Forest Service, Intermountain Region, R4-Ecol-89-01. Ogden, UT.

Manning, M.E. and W.G. Padgett. 1992. *Riparian Community Type Classification for the Humbolt and Toiybe National Forests, Nevada and Eastern California* (Draft). USDA, Forest Service, Intermountain Region. Ogden, UT.

U.S. Department of Agriculture, Forest Service. 1992. *Integrated Riparian Evaluation Guide,* Appendix I. Intermountain Region. Ogden, UT.

Hansen, P., K. Boggs, R. Pfister, and J. Joy. 1991. *Classification and Management of Riparian and Wetland Sites in Montana* (Draft Version 1). Montana Riparian Association, Montana Forest and Conservation Experiment Station, School of Forestry, University of Montana. Missoula, MT.

Cooper, S.V., K.E. Neiman, R. Steel, and D.W. Roberts. 1987. *Forest Habitat Types of Northern Idaho: A Second Approximation.* USDA, Forest Service, Intermountain Station, General Technical Report, INT-236. Ogden, UT.

14. RIPARIAN PLANT SPECIES LIST

Scientific Name	Common Name	Scientific Name	Common Name
GRAMINOIDS		**SHRUBS** (Continued)	
Agropyron trachycaulum	slender wheatgrass	*Salix drummondiana*	Drummond willow
Agrostis scabra	ticklegrass	*Salix exigua*	sandbar [coyote] willow
Agrostis stolonifera	red-top bentgrass	*Salix geyeriana*	Geyer willow
Calamagrostis canadensis	bluejoint reedgrass	*Salix glauca*	glaucous willow
Carex aquatilis	water sedge	*Salix lasiandra*	whiplash willow
Carex buxbaumii	Buxbaum sedge	*Salix lasiolepis*	arroyo willow
Carex disperma	softleaved sedge	*Salix lemmonii*	Lemmons willow
Carex douglassii	Douglas sedge	*Salix lutea*	yellow willow
Carex lanuginosa	woolly sedge	*Salix monicola*	mountain willow
Carex lasiocarpa	slender sedge	*Salix planifolia*	plainleaf willow
Carex limosa	mud sedge	*Salix scouleriana*	Scouler willow
Carex microptera	smallwing sedge	*Salix wolfii*	Wolf's willow
Carex muricata	pointed sedge	*Sarcobatus vermiculatus*	black greasewood
Carex nebrascensis	Nebraska sedge	*Symphoricarpos oreophilus*	mountain snowberry
Carex praegracilis	silver sedge	*Toxicodendron rydbergii*	poison ivy
Carex rostrata	beaked sedge		
Carex saxatilis	russet sedge	**TREES**	
Carex scirpoidea	false bulrush sedge		
Carex scopulorum	rock sedge	*Abies grandis*	grand fir
Carex simulata	analogue sedge	*Abies lasiocarpa*	subalpine fir
Danthonia intermedia	timber oatgrass	*Acer grandidentatum*	bigtooth maple
Deschampsia caepitosa	tufted hairgrass	*Acer negundo*	box elder
Distichlis spicata	inland saltgrass	*Betula occidentalis*	water birch
Eleocharis palustris	common spikerush	*Elaeagnus angustifolia*	Russian olive
Eleocharis pauciflora	few-flowered spikerush	*Juniperus scopulorum*	Rocky Mountain juniper
Elymus glaucus	blue wildrye	*Larix lyalli*	alpine larch
Elymus triticoides	creeping wildrye	*Larix occidentalis*	western larch
Festuca idahoensis	Idaho fescue	*Picea engelmannii*	Engelmann spruce
Festuca ovina	sheep fescue	*Picea glauca*	white spruce
Glyceria striata	fowl mannagrass	*Picea pungens*	blue spruce
Hordeum brachyantherum	meadow barley	*Pinus albicaulis*	whitebark pine
Hordeum jubatum	foxtail barley	*Pinus contora*	lodgepole pine
Juncus balticus	baltic rush	*Pinus monticola*	western whitepine
Phalaris arundinacea	reed canarygrass	*Pinus ponderosa*	ponderosa pine
Phleum pratensis	common timothy	*Populus acuminata*	lanceleaf cottonwood
Phragmites australis	common reed	*Populus angustifolia*	narrowleaf cottonwood
Poa palustris	fowl bluegrass	*Populus fremontii*	Fremont cottonwood
Poa pratensis	Kentucky bluegrass	*Populus tremuloides*	quaking aspen
Poa trivialis	rough bluegrass	*Populus tricocarpa*	black cottonwood
Scirpus acutus	hardstem bulrush	*Pseudotsuga menziesii*	Douglas fir
		Salix amygdaloides	peachleaf willow
SHRUBS		*Thuga plicata*	western red cedar
		Tsuga heterophylla	western hemlock
Artemesia cana	silver sagebrush	*Tsuga mertensiana*	mountain hemlock
Alnus incana	thread-leaf alder		
Betula glandulosa	bog birch	**FORBS**	
Cornus sericea	red-osier dogwood		
Crataegus douglasii	black hawthorn	*Aconitum columbiana*	monkshood
Potentilla fruticosa	shrubby cinquefoil	*Actaea rubra*	baneberry
Prunus virginiana	common chokecherry	*Agastache urticifolia*	horse-nettle
Rhus aromatica	squawbush	*Aralia nudicaulis*	wild sarsaparilla
Ribe aureum	golden currant	*Artemesia scopulorum*	dwarf sagebrush
Rosa woodsii	Woods rose	*Asarum caudatum*	wild ginger
Salix bebbiana	Bebb willow	*Caltha leptosepala*	marsh marigold
Salix boothii	Booth willow		

RIPIARIAN PLANT SPECIES LIST (Continued)

Scientific Name	Common Name	Scientific Name	Common Name
FORBS		**FORBS**	
Cirsium arvense	Canada thistle	*Mentha arvensis*	field mint
Clintonia uniflora	queencup beadily	*Mertensia ciliata*	streamsid bluebells
Conium maculatum	poison hemlock	*Mertensia fraciscana*	Flagstaff bluebells
Coptis occidentalis	western goldenthread	*Mitella breweri*	Brewer's mitrewort
Cornus canadensis	bunchberry dogwood	*Mitella pentandra*	alpine mitrewort
Disporum hookerii	Hooker fairybells	*Osmorhiza occidentalis*	western sweet-cicely
Dodecatheon jeffreyi	shooting star	*Pedicularis groenlandica*	elephant's head
Epilobium angustifolia	fireweed	*Polygonum bistortoides*	American bistort
Equisetum arvense	common horsetail	*Saxifraga odontoloma*	brook saxifrage
Geranium richardsonii	Richardson geranium	*Senecio sera*	saw groundsel
Geranium viscossisimum	sticky geranium	*Senecio triangularis*	arrowleaf groundsel
Gilium triflorum	sweetscented bedstraw	*Smilacina stella*	starry solomon-plume
Goodyera oblongifolia	rattlesnake-plaintain	*Streptopus amplexifolius*	clasping twisted-stalk
Hackelia floribunda	showy stickseed	*Thalictrum fendleri*	Fendler meadowrue
Hackelia micrantha	small-flowered stickseed	*Thalictrum occidentale*	western meadowrue
Hackelia patens	pale stickseed	*Tiarella trifoliata*	coolwort foamflower
Heracleum lanatum	cow parsnip	*Trautvetteria spp.*	false bugbane
Hydrophyllum fendleri	Fendler waterleaf	*Urtica dioica*	stinging nettle
Iris missouriensis	western iris	*Veratrum californicum*	false hellebore
Ligusticum canbyi	Canby's licorice-root	*Viola glabella*	pioneer violet
Ligusticum grayii	Grays ligusticum	*Viola obiculata*	round-leaf violet
Ligusticum tenuifolium	small ligusticum	*Xerophyllum tenax*	beargrass

15. RECONNAISSANCE - HABITAT

Stream Name: ______________________ Sub-area: __________________ Date: ________

PNRS No.: ____________ EPA Stream Reach No.: ______________________________

Agency: __________________ Observer(s): __________________ Page _____ of _____

HABITAT UNIT									
Length									
Bankfull Width									
Bankfull Depth									
Low Flow Width									
Low Flow Depth									
Maximum Low Flow Depth									
Flood Zone Width									
Tailout Depth (Pool only)									
Substrate (%)									
Sand/Silt (> 0.1")									
Gravel (0.1 to 2.5")									
Cobble (2.5 to 10")									
Boulder (< 10")									
Bedrock									
Cobble Embeddedness (%)									
Stream Banks									
Covered/Stable									
Uncovered/Stable									
Covered/Unstable									
Uncovered/Unstable									
Bank Slope > 135°									
Habitat									
Undercut Bank									
Overhanging Vegetation									
Canopy Density									
Pool Complexity (Pools only)									
Large Woody Debris (LWD)									

Total of Length of Habitat Units: Pools ________ Riffles ________ Runs ________ Glides ________

16. INSTRUCTIONS FOR RECONNAISSANCE - HABITAT

Stream Name: List the steam segment name inventoried.

Sub-Area: Provide the number or name of the sub-area described in the inventory.

Date: Date of the inventory.

PNRS No.: List the PNRS No. for the stream segment inventoried.

EPA Stream Reach No.: List the EPA stream reach number.

Agency: Provide the name of the agency responsible for the inventory.

Observer: Provide the names of the individuals completing the inventory.

Page __ of __: The current page out of all of pages of data for the sub-area.

INSTRUCTIONS COMMON TO ALL ELEMENTS

Reconnaissance inventory may be completed at various intensities from a single ocular estimate to sampling at least five stream segments in each sub-area. Inventory a sufficient number of habitat types to characterize the stream segment.

Habitat Unit: List the habitat type evaluated: Pool (PL), riffle (RF), run (RN), or glide (GD). Number each habitat type consecutively for each sub-area, i.e. PL1, PL2, RF1, RF2, RF3.

Length: Measured along the thalweg.

Bankfull Width: Measured at a specific point that is representative of the average width of the habitat unit.

Bankfull Depth: The maximum water depth at the bankfull level at the same location as the bankfull width.

Low Flow Width: The average width of the existing water level (stable low flow) for the habitat unit.

Low Flow Depth: Measure riffles, runs, and glides at the average width transect at 1/4, 1/2, and 3/4 the width of the existing water level. Measure pools along a cross-section at a midpoint between the pool tailout and the maximum depth. Add the three depths and divide by four (to compensate for the "0" depth measurement).

Flood Zone Width: The waters width at two times the bankfull depth.

Maximum Low Flow Depth: The maximum depth of the habitat unit.

Tailout Depth: The maximum depth of the pool tailout. This will give an indication of the residual pool depth.

Substrate Size: Estimate substrate composition using a Wolman Pebble Count or visual estimate.

Cobble Embeddedness: A visual estimate of cobble embeddedness of the substrate of the habitat unit. Only estimate the tailout for pool habitats. Cobble embeddedness is the percentage of cobbles embedded in sand or silt.

Bank Conditions: The percent of the length of the streambank (both banks) for the following classes:.

> *Covered and Stable (Non-erosional).* OVER 50 percent of the streambank surfaces are covered by vegetation in vigorous condition, or the banks are OVER 50 percent covered by materials (large cobble, boulders, or anchored rock) that prevent bank erosion. Streambanks are stable; that is, they DO NOT SHOW indications of alteration such as breakdown, erosion, tension cracking, shearing, or slumping.
> *Covered and Unstable (Vulnerable).* OVER 50 percent of the streambank surfaces are covered by vegetation in vigorous condition, or the banks are OVER 50 percent covered by materials that prevent bank erosion. Streambanks are unstable; that is, they DO SHOW indications of alteration such as breakdown, erosion, tension cracking, shearing, or slumping. Banks showing present erosion must be vertical or near-vertical in

form.

Uncovered and Stable (Vulnerable). LESS THAN 50 percent of the streambank surfaces are covered by vegetation in vigorous condition, or the banks are LESS THAN 50 percent covered by materials that do not allow bank erosion. Streambanks are stable; that is, they DO NOT SHOW indications of alteration such as breakdown, erosion, tension cracking, shearing, or slumping. Such banks are bare, but they are not slumping or at a vertical or near-vertical bank angle.

Uncovered and Unstable (Eroding). LESS THAN 50 percent of the streambank surfaces are covered by vegetation in vigorous condition, or the banks are LESS THAN 50 percent covered by materials that do not allow bank erosion. Streambanks are unstable; that is, they DO SHOW indications of alteration such as breakdown, erosion, tension cracking, shearing, or slumping.

Bank Slope: The percentage of the length of both banks having a slope of 135° or greater is considered gently sloping banks. The water surface is 180°. The slope of the bank above the bankfull depth.

Undercut Bank: An estimate of the length of bank that is under cut. The undercut must be at least 12 inches and within 6 inches of the waters surface. Determine the length for both banks.

Overhanging Vegetation: The percentage of the length of both streambanks having overhanging live vegetation within 12 inches of the water surface and at least 12 inch over the water.

Canopy Density: Estimate the canopy cover using a spherical densiometer or ocular estimate.

Pool Complexity Index: Pool complexity index is a total of the codes (ranges from 0 to 10) for the following factors:

Depth: The depth deepest part of the pool less the depth of the tailout (residual pool depth).

Substrate: The dominant substrate in the pool.

Overhead Cover: The percent of the pool surface covered by overhead vegetation of turbulence.

Submerged Cover: The percent of the pool covered with large organic debris, small woody debris, or other cover at or below the water surface.

Bank Cover: The percentage of the streambank (both banks) covered with stumps, roots, or other debris on the bank providing cover.

Depth	Value	Substrate	Value	Overhead Cover	Value	Submerged Cover	Value	Bank Cover	Value
< 0.5'	0	< 2.5"	0	< 10%	0	< 10%	0	< 25%	0
0.5 - 1.5'	1	2.5 - 10"	1	10 - 25%	1	10 - 25%	1	25 - 50%	1
> 1.5'	2	≥ 10"	2	>25%	2	> 25%	2	> 50%	2

Large Woody Debris (LWD): Woody debris with a length of 9 feet or 2/3 the bankfull width and at least 4 inches in diameter and within the bankfull channel unit. Record as follows:

No LWD present	0	LWD present, but infrequent	1
LWD present with some channel influence	2	LWD extensive with a major influence in channel characteristics	3

Total Length of Habitat Units: Measure or estimate total length (percentage or measured) for each of the habitat units within the sub-area, i.e. pool 50%, riffles 20%, runs 30%.

APPENDIX C

INTENSIVE - QUANTITATIVE MONITORING

1. Permanent Monitoring Site Location
2. Instructions for Permanent Monitoring Site Location
3. Field Data Sheet - Green Line Vegetation
4. Field Data Sheet - Woody Species Age Class
5. Field Data Sheet - Herbaceous Species Stubble Height Utilization
6. Field Data Sheet - Woody Species Twig Count Utilization
7. Field Data Sheet - Utilization - Ocular Estimate
8. Field Data Sheet - Streambank/Overhanging Vegetation
9. Field Data Sheet - Canopy Density and/or Thermal Input
10. Photo Identification Marker

1. PERMANENT MONITORING SITE LOCATION DATA

Site Number: ____________ Date Established: _________ Storet No.: ___________

Agency ID No.: ___________ Waterbody Name: _____________________________

EPA Stream Reach No. _____________________________ PNRS No.: ___________

Management Unit Name: ___________________ Management Unit Number: _______

Project Name: ____ Project No. ______

Longitude: ______ Latitude: ______ Twnshp: ______ Rng: ______ Sctn: _________

Tract: ___ 1/4 ___ 1/4 ___ 1/4 ___ 1/4, lot ___ Elevation: Upper _____ Lower _____

Type of Witness Marker: ____

Length of Reach: ______ No. Cross-channel Transects: ______ Transect Interval: ______

Description of Transect Location:

Parameters Monitored:

Permanent Photo Pnt.	___	Green Line Vegetation	___	Woody Species Age Class	___
Canopy Density	___	Solar Input	___	Overhanging Vegetation	___
Vegetation Util.	___	Streambank Stability	___	Cross-Channel Profile	___
Thalweg Profile	___	Artificial Redds	___	Intergravel DO	___
Substrate embed.	___	Percent fines (Grid)	___	Substrate living space	___
Stream Gradient	___	Residual Pool Index	___	Pool-riffle Ratio	___
Stream habitat div.	___	Stream Temperature	___	Stream flow Variation	___
Undercut Banks	___	Pool Complexity	___	Percent Fines (Wolman)	___
Macroivert. (Recon)	___	Fish (Recon)	___	Macroivertebrate (Intensive)	___
Fish (Intensive)	___				

Other Parameters and/or Comments:

Site Map:

2. INSTRUCTIONS FOR PERMANENT MONITORING SITE LOCATION

A Permanent Monitoring Site Location Data form should be completed for each permanent monitoring site, including permanent photo points. This will provide a detailed record of the location and the parameters that are being monitored at the site.

Site Number: The number or designator for the study site.

Date Established: The date the monitoring site is established

STORET No.: The assigned EPA STORET number assigned, if any.

Agency ID No.: Number or designator assigned by the responsible agency.

Waterbody Name: The name of the stream reach or waterbody and sub-area designator.

EPA Stream Reach No.: The EPA stream reach number in which the site is located.

PNRS No.: The PNRS number of the segment in which the site is located.

Management Unit Name: The name of the landowner, allotment, or other name used for the area being monitored.

Management Unit Number: A number assigned by an agency, i.e. allotment number (optional)

Project Name: The name of the project initiating monitoring.

Project No.: The project number, i.e. SAWQP, Riparian Demonstration.

Longitude and Latitude: The location of the site to the nearest minute and second.

Twnshp: Township in which the site is located.

Rng: Range in which the site is located.

Sctn: Section in which the site is located.

Tract: Mark the site location to the nearest 2.5 acre tract.

Lot: List the government lot number for the site. Leave blank if the tract is completed.

Elevation: Provide the upper and lower elevation of the monitoring site. List only a single elevation for sites such a photo points or STORET sites.

Type of Witness Marker: Describe the witness marker(s) used to identify the site. Describe the cross-channel transect markers and transect numbers.

Length of Reach: Provide the total length of the study site reach.

No. of Cross-Channel Transects: Provide the number of cross-channel transects at the monitoring site.

Transect Interval: List the distance between cross-channel transects.

Description of Study Location: Describe the study site location in detail to allow relocating the site in the future.

Parameters Monitored: Mark all of the parameters monitored at the site. Describe other parameters, not listed or added to an existing plot.

Site Map: Provide detailed site map with permanent landmarks, distances, directions, or any other information that will assist with relocating the site.

3. RIPARIAN GREEN LINE VEGETATION

Stream Name: ______________ Sub-area: ______________ Date: ______________

PNRS No.: ______________ EPA No.: ______________ Site No.: ______________

Examiner(s): ______________

Location: ______________

TRANSECT DATA											
Community Type	DISTANCES (ft. or m)										
	1	2	3	4	5	6	7	8	9	10	Tot
TOTAL											

Comments:

4. WOODY SPECIES AGE CLASS

Stream Name: ______________ Sub-area No.: ______________ Date: ______________

Site No.: ______________ Examiner: ______________

Location: ______________

WOODY SPECIES BY AGE CLASS												
SPECIES	NUMBER OF PLANTS											
	SPROUT		YOUNG		MATURE		DECADENT		DEAD		TOTAL	
	L	R	L	R	L	R	L	R	L	R	L	R
TOTALS												

Comments:

5. HERBAGE STUBBLE HEIGHT

Stream Name: ____________ Sub-area: ____________ Site No.: ____________

Pasture: ____________ Examiner: ____________ Date: ____________

Location: ____________

POINTS	Species				POINTS	Species				POINTS	Species				POINTS	Species			
1					26					51					76				
2					27					52					77				
3					28					53					78				
4					29					54					79				
5					30					55					80				
6					31					56					81				
7					32					57					82				
8					33					58					83				
9					34					59					84				
10					35					60					85				
11					36					61					86				
12					37					62					87				
13					38					63					88				
14					39					64					89				
15					40					65					90				
16					41					66					91				
17					42					67					92				
18					43					68					93				
19					44					69					94				
20					45					70					95				
21					46					71					96				
22					47					72					97				
23					48					73					98				
24					49					74					99				
25					50					75					100				
T_1																			
T_2																			

T_1 Total number of points with vegetation measured
T_2 Total inches of vegetation measured

6. WOODY SPECIES UTILIZATION - TWIG COUNT

Stream Name: ______________ Sub-area: ______________ Site No.: ______________

Pasture: ______________ Examiner: ______________ Date: ______________

Location: ____

Woody Species Twig Count				
Woody Species	Twigs Counted			
	Plants Browsed	Total	Plants Unbrowsed	Total

Total Twigs Browsed _____ ÷ Total Twigs Counted _____ X 100 = _____ % Browse Utilized

Comments:

7. UTILIZATION - OCULAR ESTIMATE

Stream Name: ____________ Sub-area: ____________ Date: ____________

Site No.: ____________ PNRS No.: ____________ EPA No.: ____________

Observation Interval: ____________ Beginning Point: ____________

Location: ____________

Slight (0 to 20%)	Light (21 to 40%)	Moderate (41 to 60%)	Heavy (61 to 80%)	Severe (81 to 100%)	Total Hits
Right Bank					
Bank Totals					
Left Bank					
Bank Totals					
Site Totals					Total 1
Mid-Point 10	30	50	70	90	
Category Products					Total 2

Total 2 ____________ ÷ Total 1 ____________ = Average Utilization (%)

Comments:

8. STREAMBANK/OVERHANGING VEGETATION

Stream Name: ____________ Sub-area: ____________ Date: ____________

Site No.: ____________ PNRS No.: ____________ EPA No.: ____________

Examiners: ____________

Location: ____________

TRANSECT DATA (Distance in ft.)											
TRANS #	Left Bank					TRANS #	Right Bank				
	Covered/ Stable	Covered/ Unstable	Uncovered/ Stable	Uncovered Unstable	Overhang Veg		Covered/ Stable	Covered/ Unstable	Uncovered/ Stable	Uncovered/ Unstable	Overhang Veg
1						1					
2						2					
3						3					
4						4					
5						5					
6						6					
7						7					
8						8					
9						9					
10						10					
TOT						TOT					

TRANSECT TOTALS

Covered/Stable: ____________ Covered/Unstable: ____________

Overhanging Vegetation: ____________

Uncovered/Stable: ____________ Uncovered/Unstable: ____________

Comments:

9. CANOPY DENSITY AND/OR THERMAL COVER

Stream Name: ____________ Sub-area: ____________ Date: ____________

Site No.: ____________ PNRS No.: ____________ EPA No.: ____________

Examiners: ____________

Location: ____________

PARAMETER	TRANSECT DATA										
	1	2	3	4	5	6	7	8	9	10	Total
Canopy Density *Right Bank*											
Canopy Density *Center* Up											
Canopy Density *Center* Down											
Canopy Density *Left Bank*											
Total Number											
Thermal Input *June*											
Thermal Input *July*											
Thermal Input *August*											
Thermal Input *September*											
Total Thermal Input											

CANOPY DENSITY

Total for all transects ______ ÷ Total No. Transects ______ X 1.5 = ______ Average Canopy Density

THERMAL INPUT

	Total % Potential		Total Transects		Average % Solar Input		BTUs/sq. ft. Potential		BTUs/sq. ft.
June	______	÷	______	=	______	X	______	=	______
July	______	÷	______	=	______	X	______	=	______
August	______	÷	______	=	______	X	______	=	______
September	______	÷	______	=	______	X	______	=	______

Total Solar Input for the Season (BTUs/sq. ft.) ______

Comments:

Stream
Name ______________________________

Site No. ______________________________

Mgmt.
Unit ______________________________

Date ______________________________

APPENDIX D

EQUIPMENT

1. Field Equipment List
2. Equipment - Sources and Approximate Costs

1. FIELD EQUIPMENT LIST

RECONNAISSANCE LEVEL

Aquatic Thermometer	Spherical Densiometer
Hand Level or Abney (for determining Flood Zone)	Boots (for wading)
Calculator (pocket)	Camera and Film (35mm)
Photo ID Marker	Field forms and Instructions
Tape (100 ft. min.)	Topographic Map, Aerial Photos
Level Rod (for measuring depths)	Protocol 8

INTENSIVE LEVEL

Six foot staff (Woody Species Age Class)	Pace Counter (Tally Wacker)
Reference stakes for cross-channel transects	Witness markers (steel posts)
Numbered Tags for reference stakes	Spray paint
Measuring Tape (at least 100 feet)	Measuring stick (stubble height)
35mm Camera and film	Aerial photos
Protocol 8	Supply of Field Forms
Boots or chest waders	Hand lens (magnifying)
Plant Identification Key	Community Type Key
Range Rod or Vegetation Profile Board	Photo ID Marker

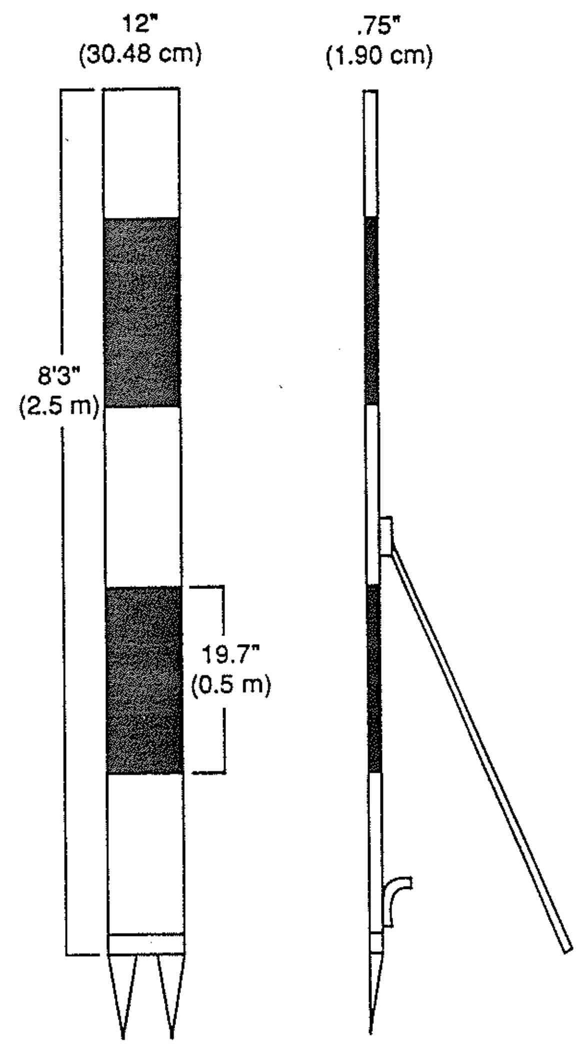
2. EQUIPMENT - SOURCES AND APPROXIMATE COSTS

Equipment List	Source	Approximate Cost
Spherical Densiometer, Model C (Concave)	Forest Densiometers 2413 N. Kenmore St. Arlington, VA 22207 (Only Known Source)	$ 75.00
Solar Pathfinder With "F" chart energy data pack, Sun Path Charts for Idaho, tripod and metal carrying case	Solar Pathways, Inc. 31 Chapar Circle Glenwood Springs, CO 81601 (Only Known Source)	149.00
Range Rod (8 foot)	Forestry Suppliers P.O. Box 8397 Jackson, MS 39284-8397 (Available from most engineering supply firms)	35.00
100 foot nylon tape (feet, 10ths, and 100ths), open faced reel to prevent water damage	Forestry Suppliers or most engineering supply firms	20.00
Numbered Tags (Aluminum or Brass)	Forestry Suppliers or other engineering supply firms	12.25 per 100
Telescoping Level Rod (oval fiberglass)	Forestry Suppliers or other engineering supply firms	120.00
Folding Rule 6'(10ths)	Engineering and building supply firms	18.00
Cross-channel transect markers (3/8" or 1/2" X 18")	Building supply or steel suppliers	50.00 per 100
Plastic caps for cross-channel markers	Forestry Suppliers	30.00 per 100
Steel Posts	Farm supply firms	3.00 each
Spray Paint (Florescent)	Paint suppliers	3.50 /can

APPENDIX E

VEGETATION PROFILE BOARD

To make a vegetative profile board, use 1/2 to 3/4 inch exterior plywood or 3/16 inch aluminum sheeting. It is 12 inches wide and 96 inches tall. Steel or aluminum spikes are fastened to the bottom the board to allow it to be free standing. The board is painted alternating black and white at 0.5 meters or 19.7 inch intervals.



Vegetation profile board diagram (USDI 1989).